

ASTM BULLETIN

260 SOUTH BROAD STREET

PHILADELPHIA, PA.

"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"

TELEPHONE—PENNypacker 3545

CABLE ADDRESS—TESTING

Number 88

October, 1937

Reports on A. S. T. M. Research Activities—1937

Work Involves: I.—Properties of Materials; II.—Methods of Testing

A COMPREHENSIVE review of the large number of research projects on which the standing committees of the Society are engaged was published in the October, 1936, BULLETIN. Many of the committees have recorded in their 1937 reports important progress on a number of projects. In addition to these, 15 new projects have been instituted, some of which are just getting under way. Two of these are primarily concerned with the properties of cast iron and tin- and lead-base die casting alloys; the other 13 with test methods. Of the latter, four pertain to non-ferrous metals and alloys; two concern petroleum products, and there is a new project in each of the following fields: structural clay tile, fire tests, asphalt-salt mixtures, coal and coke, liquid rubber products, bast fibers, and soils.

In order that members may be currently informed on the projects on which committees have presented additional information and data and also learn of new projects which have been established, there appear below summaries of these activities. The new projects are indicated by stars.

As President White points out in his message in this BULLETIN "research is the backbone of standardization—without research there can be no intelligent standardization" and he indicates that "research must go forward."

Prof. H. F. Moore, University of Illinois, during his term as President of the Society discussed the spirit of research in A.S.T.M. He wrote that "to some persons, the term 'research' conveys the idea of experimental studies in unexplored fields of science, such work as the X-ray

studies of the constitution of matter. . . . To others, especially to committees or other organized groups, research means the correlating of discoveries in partially explored fields, and the systematizing and codifying of the correlated work. Each type is equally necessary to the advancement of the knowledge of materials. Both of these are exemplified in the work of the Society and their direct importance in the Society is obvious.

"The indirect results of the spirit of research are less obvious but perhaps equally important. This spirit of research, an intellectual curiosity to find out the truth, has become a large factor in our specification work as well as in our distinctively research work. Let us see to it that this research spirit pervades all our Society activities."

That the research spirit does pervade Society activities is very evident from the review of research projects which appears below and from a study of the activities of the Society committees.

In accordance with the arrangement used in the 1936 list the summaries which follow have been divided into two parts: Part I—Research on Properties of Materials, and

Part II—Research on Methods of Testing.

These statements provide information not otherwise generally available, except through reference to the current reports of the standing committees. Reference is made in every case to the latest report on each project. Reports now appearing in preprints prepared for the 1937 annual meeting will be published in the 1937 *Proceedings*, available in December.

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Part I—Research on Properties of Materials

Corrosion of Ferrous and Non-Ferrous Metals

Atmospheric Corrosion Tests of Uncoated Sheets (Committee A-5).—Exposure tests of bare (uncoated) steel and iron sheets under atmospheric conditions at Pittsburgh, Pa., Fort Sheridan, Ill., and Annapolis, Md.

Tests completed at Pittsburgh in 1923 and at Fort Sheridan in 1928, see *Proceedings*, Vol. 23, Part I, p. 147 (1923); Vol. 28, Part I, p. 152 (1928), respectively. Annapolis tests still in progress; complete record of failures of No. 22 gage sheets reported, see reprint, 1937 Report of Committee A-5.

Atmospheric Corrosion Tests of Electroplated Coatings on Non-Ferrous Metals (Joint Committee of American Electro-Platers' Society, National Bureau of Standards and A.S.T.M.).—Investigation of value of electroplated coatings of nickel, copper, chromium, cadmium, zinc or combinations of these metals on specimens of copper, brass, nickel-brass, rolled zinc, zinc die castings, and iron after atmospheric exposure at 6 test locations, namely, Key West, Fla.; New York, N. Y.; Pittsburgh, Pa.; Sandy Hook, N. J.; State College, Pa., and Washington, D. C. Tests also include continuation of certain specimens from earlier investigation of coatings on



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steel and some repeat tests on steel specimens. For progress report on inspection of plated coatings on non-ferrous metals at the 6 test locations, see *ASTM Bulletin*, April, 1937.

Atmospheric Corrosion Tests on Wire and Wire Products (Committee A-5).—Comprehensive corrosion studies, at 11 test locations, of wire and wire products, including unfabricated wire, barbed wire, wire strand, farm-field fencing and chain-link fence. Materials to be tested include: Uncoated wire and fencing (both copper-bearing and non-copper-bearing), zinc-coated wire and fencing, corrosion-resistant steel wire and fencing, copper-covered wire and fencing, and lead-coated wire and fencing. Test sites, representative of atmospheric conditions from coast to coast, are State College, Pa.; Lafayette, Ind. (Purdue University); College Station, Tex. (Texas Agricultural Experiment Station); Ames, Iowa (Iowa State College); Ithaca, N. Y. (Cornell University); Pittsburgh, Pa.; Sandy Hook, N. J.; Bridgeport, Conn.; Manhattan, Kans.; Davis, Calif.; Santa Cruz, Calif. For detailed report on installation of test materials at exposure locations see reprint, 1937 Report of Committee A-5.

Accelerated Corrosion Tests (Committee A-5).—Study of various methods of accelerated corrosion tests, with particular reference to their application to metallic-coated products. Symposium on Corrosion Testing Procedure held this year, comprising 6 papers on principles of testing, atmospheric corrosion, salt spray, alternate immersion and water-line tests, and total immersion and soil corrosion testing, also contributed discussion, issued as separate reprint.

Total Immersion Tests on Uncoated Sheets (Committee A-5).—Tests on bare (uncoated) steel and iron sheets immersed in acid mine water at Calumet, Pa.; in saline water in Annapolis, Md.; in city water at Washington, D. C.; in sea water at Key West, Fla.; Portsmouth, N. H., and Port Arthur, Tex.; also tests in open sea water to determine the effect of corrosion on copper-steel pipe and on steel ship plate, with and without copper, when riveted with rivets of iron and steel with varying copper contents.

Tests completed at Calumet in 1921, at Washington in 1928, and at Annapolis in 1930, see *Proceedings*, Vol. 21, p. 157 (1921); Vol. 28, Part I, p. 160 (1928); Vol. 30, Part I, p. 223 (1930), respectively. All No. 22 gage sheets at Portsmouth and Key West have failed; for detailed record of failures, see *Proceedings*, Vol. 32, Part I, p. 105 (1932); Vol. 33, Part I, p. 144 (1933). For detailed record of failures of No. 16 gage sheets at Key West, Fla., and Portsmouth, N. H., see *Proceedings*, Vol. 36, Part I, p. 104 (1936). Tests at Portsmouth completed 1937; also 14 additional failures found at Key West, see reprint, 1937 Report of Committee A-5.

Ferrous and Non-Ferrous Metals, General

Research on Yield Point of Structural Steel (Research Committee).—The committee will consider (1) what is the range of yield point of structural steel (that is, low-carbon, medium-carbon, silicon and nickel steels), due to a number of important factors, when furnished under specifications; and (2) what testing procedure will insure sufficiently correct determination of the yield point at minimum expense and (3) the significance of the yield point to the engineer. The committee has reported four series of tests on Item (2) dealing mainly with effect of speed of movable head on yield point of structural steel. See *Proceedings*, Vol. 27, Part I, p. 646 (1927); Vol. 28, Part I, p. 105 (1928); Vol. 29, Part I, p. 101 (1929); and Vol. 31, Part I, p. 136 (1931). Report of tests on specimens from structural steel shapes, Vol. 30, Part I, p. 133 (1930), contains data on range in yield point, ratio of yield point to ultimate strength and effect of location of test specimen.

Current report contains results of tests to determine the effect of aging on the yield point and other mechanical properties of structural steel rods. This final report includes résumé of replies to questionnaire on significance of yield point to the designing engineer, and conclusions and recommendations resulting from work of the committee, see reprint, 1937 Report of Research Committee.

Study of Grain Boundary Precipitation in Chromium-Nickel Alloy Steel (Committee A-10).—Investigation of the phenomenon of grain boundary precipitation in the 18 per cent chromium, 8 per cent nickel alloy steels with a view to determining the nature of the precipitate. Studies are being undertaken on two heats of these

steels in three conditions, quenched, medium and badly precipitated as to carbide. Preliminary microscopic examination completed and being studied, see preprint, 1937 Report of Committee A-10.

Effect of Temperature on the Properties of Metals (Joint Research Committee of A.S.M.E. and A.S.T.M.).—The scope of these investigations includes (1) an accumulation of service data of various metals under extreme temperatures; (2) studies leading to standardization procedure for testing metals at high and low temperatures; and (3) outlining and fostering new research work in this field, giving consideration first to the various metals and alloys intended for high-temperature service in power stations, oil refineries, etc. See report of Joint Committee for 1931, *Proceedings*, Vol. 31, Part I, p. 106 (1931).

Tests for short-time and for long-time (creep) high-temperature tension tests of metallic materials developed; results of tests and other data in explanation of the test methods reported, see *Proceedings*, Vol. 33, Part I, pp. 996, 1004 and 209 (1933).

Current report contains summary of new and continued research projects which include creep tests on tubes, study of torsion-creep tests for comparison with tension-creep tests, relaxation tests, study of effects of manufacturing variables on creep resistance of steels, assembly and interpretation of creep data, investigation of properties of metals at low temperatures, study of high-temperature life test methods, and continuation of long-time creep tests. This report also includes results of long-time creep tests of 18 per cent chromium, 8 per cent nickel steel, and 0.35 per cent carbon steel, a paper on discrepancies in the load carrying abilities of carbon steels at 850 F., and revisions of the test for short-time high-temperature tension tests, see preprint, 1937 Report of Joint Committee which also lists titles of reports and papers on creep and relaxation tests of metals sponsored by the Joint Committee in cooperation with the Committee on Plasticity of the A.S.M.E. Division of Applied Mechanics and presented in December, 1936, before the American Society of Mechanical Engineers.

Attention is also called to the Symposium on Effect of Temperature on the Properties of Metals held at the 1931 annual meeting and sponsored by the Joint A.S.M.E.-A.S.T.M. Research Committee. Symposium published, contains 27 papers with discussion.

***Fatigue Tests of Cast Iron** (Committee A-3).—Study of effects of understressing and overstressing on endurance limit of cast iron. See preprint, 1937 Report of Committee A-3.

Fatigue of Metals (Research Committee).—The broad purpose of the committee is to summarize and correlate the work that various laboratories are doing in connection with the fatigue of metals and to study the relationship between fatigue failure and other strength properties of metals and their atomic and metallographic structure. The committee has prepared abstracts of articles on fatigue of metals under repeated stress appearing in the technical press from July 1, 1928, to June 30, 1930. Consideration being given to method of studying fatigue phenomena by use of "probable damage line" for metals under repeated stress. For a brief statement of the "present status of knowledge and current theory in the field of fatigue of metals" and a "summary of knowledge on corrosion-fatigue and on significance and limitations of fatigue test results," see *Proceedings*, Vol. 30, Part I, p. 259 (1930), Vol. 32, Part I, p. 139 (1932). See also 1933 Edgar Marburg Lecture by H. J. Gough on "Crystalline Structure in Relation to Failure of Metals—Especially by Fatigue," reprint pamphlet, also *Proceedings*, Vol. 33, Part II, p. 3 (1933).

Abstracts, prepared by the Research Committee, on fatigue studies appear currently in *Metals and Alloys*.

Current report contains pertinent notes and comments on fatigue studies and includes discussion on nomenclature for various ranges in stress in fatigue, see preprint, 1937 Report of Research Committee.

X-ray Metallography (Committee E-4).—A study of the applications of the X-ray (1) in the location of cavities and cracks and other structural variations in metals (metal radiography); (2) to determine the arrangement of atoms or molecules in crystals, size of grain in crystalline aggregates and the orientation of such crystalline material (X-ray crystallography). Symposium on Radiography and X-ray Diffraction Methods held in 1936, comprising 12 papers, issued as separate publication.



Study reported of X-ray diffraction as a means of detecting impending fatigue failure, carried on in cooperation with Research Committee on Fatigue of Metals, see preprint, 1936 Report of Research Committee.

Investigation of Aluminum-, Zinc- and Magnesium-Base Die-Casting Alloys (Committee B-6).—An extensive investigation of die-casting alloys as to composition, strength, hardness, brittleness and resistance to corrosion; also finishing properties of die castings. Studies cover commercial compositions of aluminum-base, zinc-base and magnesium-base alloys. Purpose of investigation is to supply dependable information on the properties of alloys suitable for die castings and the formulation of specifications based either on the alloys tested or on alloys developed as a result of the investigation. Specifications have been issued.

Data showing physical properties of aluminum-base die-casting alloy specimens after 1-yr. exposure at 5 outdoor test locations and 4 indoor locations reported, see *Proceedings*, Vol. 32, Part I, p. 265 (1932). For report on inspections of zinc-base die-cast specimens after 4-yr. exposure at 6 outdoor test locations, see *Proceedings*, Vol. 34, Part I, p. 255 (1934). Report for 1935 covers results of 5-yr. exposure tests of 12 aluminum and 10 zinc alloys cast by several producers and exposed at 6 outdoor and 4 indoor locations; data presented covers chemical analysis, tension, impact and expansion tests; also description of photographic inspections of specimens of all alloys after 4-yr. outdoor exposure at 6 locations, see *Proceedings*, Vol. 35, Part I, p. 190 (1935).

Corrosion test program expanded to include exposure of 4 magnesium-base alloys and 3 additional zinc-base alloys. Zinc alloys to be die cast in accordance with procedure outlined in paper by G. L. Werley on "A Study of Die Design Changes for the Improvement of the Soundness and Uniformity of Test Bars," see reprint, 1937 Report of Committee B-6.

***Investigation of Tin- and Lead-Base Die-Casting Alloys** (Committee B-6).—A study of 5 tin-base and lead-base alloys to determine tensile strength, creep, impact, and hardness. Composition of the alloys will be determined by chemical and spectrographic analyses. See reprint, 1937 Report of Committee B-6.

Cement

Compressive Strength Tests of Cement Mortars (Committee C-1).—Development of satisfactory commercial test for compressive strength of portland-cement mortars. Comprehensive investigation undertaken on 12 cements by 10 laboratories to study effect on results of refinements in proposed test procedure; relation between standard tension and plastic mortar strength results; the relative merits of standard Ottawa *versus* graded Ottawa sand for cube tests, to obtain data as basis of possible specification requirements; effect of rate of loading on results, and to secure voids-cement ratio as possible further refinement in test. Extensive data reported and tentative method prepared, see *Proceedings*, Vol. 34, Part I, pp. 322 and 743 (1934). Consideration being given to problems inherent in standard compression test. Cooperative investigation by 13 laboratories on use of concrete instead of mortar as an acceptance test for cement being undertaken, see preprint, 1937 Report of Committee C-1.

Volume Change and Soundness of Portland Cement (Committee C-1).—To obtain information on (1) volume change of neat cement bars when subjected to various temperatures and storage conditions and (2) the influence of cement on volume change characteristics of neat cement, mortar and concrete under various conditions of storage. Data reported on item one for 16 commercial cements, see *Proceedings*, Vol. 34, Part I, p. 356 (1934). Other studies described in paper by H. F. Gonnerman on "Study of Cement Composition in Relation to Strength, Volume Change, Resistance to Sulfate and to Freezing and Thawing of Mortars and Concrete," see *Proceedings*, Vol. 34, Part II, p. 244 (1934). Report for 1936 contains results of tests for expansion or contraction in neat cement bars made on 34 high-early-strength cements, see *Proceedings*, Vol. 36, Part I, p. 225 (1936). A series of cooperative tests being inaugurated in 10 laboratories to develop a suitable standardized procedure for making autoclave tests, details of proposed test procedure published as information, see preprint, 1937 Report of Committee C-1.

Concrete

Studies of Concrete Aggregates (Committee C-9).—A study of the various properties of aggregates for concrete, including soundness, resistance to abrasion, absorption and influence of shape, fineness and soft particles on quality of concrete; also freezing and thawing tests. Tests developed for soundness of aggregates and test for abrasion of coarse aggregate by use of Los Angeles machine completed, specifications for lightweight aggregate issued as tentative, see preprint, 1937 Report of Committee C-9.

Effect of Speed of Testing on Concrete (Committees C-9 and E-1).—Investigative studies on the effect of varying the speed of testing upon the strength and elastic properties of concrete. Tests carried out at University of Illinois reported in a paper by Paul G. Jones and F. E. Richart entitled, "The Effect of Testing Speed on Strength and Elastic Properties of Concrete," *Proceedings*, Vol. 36, Part II, p. 380 (1936). This year's work is devoted to a study of inelastic deformation as affected by rate of loading and particularly by the time interval that the load is held constant at each interval of loading. The results should be of considerable value in showing the relation between plastic flow at very short periods of time and creep or flow which has been observed over long-time intervals.

Relation of Characteristics of Materials and Mixtures to Properties of Concrete (Committee C-9).—To study the effects of characteristics of materials and mixtures upon the properties of concrete. An important feature is a critical review of the existing information relating to the factors affecting the proportioning of materials for concrete. No report available.

Admixtures in Concrete (Committee C-9).—A general study of admixtures which may be added to concrete for the purpose of improving some of its properties. For progress report containing a summary of manufacturers' data on various commercial admixtures, see *Proceedings*, Vol. 29, Part I, p. 305 (1929). Recent analysis of present situation with respect to admixtures has revealed that until new information is developed little progress can be expected toward the contemplated objectives. It is realized that admixtures are important and pending further developments this project is being held in abeyance by the committee, see preprint, 1937 Report of Committee C-9.

Mineral Aggregates

Research in Mineral Aggregates (Highway Research Board).—Correlation of research in mineral aggregates under auspices of the Highway Research Board, National Research Council. Considerable information assembled on the nature of shale and its effect when present in aggregates used in concrete and on coatings of various sorts on aggregates and their effects. Abrasion, hardness and toughness tests are receiving attention, and the significance of flat or elongated particles in aggregates is being considered. The Board is in constant touch with researches throughout the country on accelerated durability tests for aggregates. The standardization of an accelerated test and correlation with service behavior is recognized as a pressing necessity, and the Board is seeking to encourage coordination in these researches by distributing research outlines to interested agencies. See Report of Joint Committee, *Proceedings*, Highway Research Board, Vol. 12, Part I, p. 265 (1932).

Report on status of the sulfate crystallization test for soundness of aggregates was presented at Highway Research Board Meeting, December, 1936. Cooperative investigation involving Los Angeles and Deval abrasion tests has been undertaken. No report available.

Paint and Paint Materials

Accelerated Tests for Protective Coatings (Committee D-1).—A study of accelerated weathering tests for such protective coatings as house paints, enamels, varnishes, lacquers and metal protective finishes; also correlation of the results with outdoor exposure tests. Specifications prepared for wood panels used in weather tests of paints and varnishes.

Report for 1936 records results of two series of accelerated weathering tests on 6 varnishes applied on primed steel panels. First series included tests by 5 laboratories using 7 types of machines; second series covers tests by 6 laboratories on the 4 most satisfactory



machines together with exterior exposures at 3 locations. Kauri reduction and photochemical embrittlement tests were also made. Report includes integrity rating of test panels and order of durability rating of the varnishes studied. See *Proceedings*, Vol. 36, Part I, p. 366 (1936). For current progress, see preprint, 1937 Report of Committee D-1; also report on house paint exposure tests for gloss retention and chalking, see *Proceedings*, Vol. 37, Part I (1937).

Symposium on "Correlation Between Accelerated Laboratory Tests and Service Tests on Protective and Decorative Coatings" held this year, comprising 25 papers and discussions, issued as separate publication.

Study of Hiding Power and Tinting Strength of Paint Pigments and Paints (Committee D-1).—Scope of investigation covered by title. Test procedures adopted for tinting strength of white pigments and pastes and for mass color and tinting strength of dry color pigments and pastes, see 1936 Book of A.S.T.M. Standards, Part II; also *Proceedings*, Vol. 36, Part I, p. 359 (1936). Studies made of a new method for hiding power of paints, working at incomplete hiding and on a dry film basis, resulted in development of revised methods of test for relative dry hiding power of paints and of white pigments, see preprint, 1937 Report of Committee D-1.

Rubber Products

Properties of Rubber and Rubber-Like Materials in Liquids (Committee D-11).—Study of volume changes of rubber compounds when subjected to the action of oils or various solvents

and the development of suitable test methods for comparing the swelling properties. Conclusions resulting from study of factors affecting rate of deterioration of specimens in such tests reported, see preprint, 1937 Report of Committee D-11. Methods of test for changes in properties of rubber and rubber-like materials in liquids issued as tentative, see *Proceedings*, Vol. 37, Part I (1937).

Boiler Feedwater

Studies of Boiler Feedwaters (Joint Research Committee under Joint Sponsorship of Six Societies).—Investigative research on boiler feedwaters including studies of caustic embrittlement, coagulation and sedimentation, foaming and priming, organic chemicals in water treatment, electrolytic prevention of scale and corrosion, effects of treated water in accelerating or relieving corrosion, effect of solution composition on cracking of boiler metal, and steam-metal reactions at high temperatures. See papers presented by A. H. White, D. W. Button and C. H. Leland, "The Determination of Oxygen in Boiler Water"; W. C. Schroeder, A. A. Berk and E. P. Partridge, "Effect of Solution Composition on the Failure of Boiler Steel Under Static Stress at 250 C."; and by W. C. Schroeder, A. A. Berk and E. P. Partridge, "The Use of Solubility Data to Control the Deposition of Sodium Sulfate or Its Complex Salts in Boiler Waters," *Proceedings*, Vol. 36, Part II, pp. 697, 721, 755 (1936).

Current report covers study of effect of solution on the inter-crystalline cracking of boiler steel, including investigation of production of cracking and of prevention of cracking; progress reported on other studies, see *ASTM Bulletin*, August, 1937.

Part II—Research on Methods of Testing

Ferrous and Non-Ferrous Metals

Tests for Weight of Coating on Zinc-Coated Hardware (Committee A-5).—Study of solutions and methods for stripping, methods for determining area of irregular shaped articles and use of coupons to eliminate calculations of area, microscopic and magnetic methods, limitations of Preece test for estimating weight of coating and uniformity, and mechanical tests such as scratch hardness, distortion or direct measurement before and after solution of coating. Results being studied of extensive work on the Preece test from standpoint of effect of shape of articles on number of dips obtained, effect of proximity of zinc to bare areas, and application of stripping test to galvanized malleable and gray cast iron. No report available.

***Tests for Weight or Thickness of Plated Coatings** (Committee A-5).—Studies of several methods, including metallographic, stripping, the chord method, dropping, jet, and spot tests, and a newly developed magnetic method for nickel coatings. No report available.

Mechanical Tests of Heating and Resistance Alloys (Committee B-4).—Investigations of tests for determining stiffness of electrical resistance wires. Proposed method for the bend testing of wire covering three types of machines in which stiffness is measured by angle of permanent bend of specimen published as information, see *Proceedings*, Vol. 36, Part I, p. 162 (1936). The three types of bend testing machines together with a torsion test being studied by comparative tests on nickel wire, see preprint, 1937 Report of Committee B-4.

Studies of Heating and Resistance Alloys at High Temperatures (Committee B-4).—Tests for thermal conductivity, tests for thermal coefficient of linear expansion, and a study of warpage to determine its relation to thermal expansion and heat conductivity. Test developed for linear expansion of metals, see *Proceedings*, Vol. 34, Part I, pp. 244 and 733 (1934). Consideration also being given to oxidation, corrosion, bend, and compression tests at high temperatures. Appendix to methods of test for short-time high-temperature tension tests of metallic materials covering preparation of cast tension specimens of heat resistant metals prepared, see preprint, 1937 Report of Joint Research Committee on Effect of Temperature on the Properties of Metals; also 1937 Report of Committee B-4.

Tests for Evaluating Thermostatic Metals (Committee B-4).—Survey of methods of test for "thermoflex" (thermostatic metals); also preparation of units and definitions of terms used in connection with the specifying and testing of these metals. Test for flexivity (flexure-temperature characteristics) of thermoflex developed. Methods of evaluating stiffness, elastic strength and permissible range of operating temperature, see preprint, 1937 Report of Committee B-4.

***Tests for Metallic Materials for Radio Tubes and Incandescent Lamps** (Committee B-4).—Substantially as stated by title. Proposed program divided among five sections: on strip, wire, tubing, coated material, and powdered materials and liquids. Immediate work to cover preparation of test methods for the temper of wire and for thin sheets of metal used in radio tubes. Work also to be carried out on the collapsing strength of fine tubing used for cathodes in radio tubes (being correlated with tension tests). Study under way; no report available.

***Effect of Controlled Atmospheres Upon Electric Furnace Resistors and Structures** (Committee B-4).—Study of a suitable method of test to determine the durability of resistor alloys exposed to controlled atmospheres at high temperatures in electric furnaces. Work proposed, see preprint, 1937 Report of Committee B-4.

Tests of Anodic Oxidation of Aluminum and Aluminum Alloys (Committee B-7).—Study of methods of tests for anodized coatings and the ability of such coatings to withstand various service conditions. Current report contains accumulated data and information on methods of testing oxide coatings on aluminum, including tests for thickness, resistance to abrasion, and measurement of insulating value (electrical breakdown voltage) of oxide coatings, see preprint, 1937 Report of Committee B-7.

***Tests for Light Metals** (Committee B-7).—Study of various problems relating to testing of aluminum alloys and magnesium alloys, including tensile properties, hardness tests, effect of speed of testing, effect of foundry technique on physical properties of cast test bars including effects of design, gating and chilling. Study reported by R. L. Templin and Sam Tour in paper on "Modulus of Elasticity of Aluminum Alloys" (not preprinted), see *Proceedings*, Vol. 37, Part I (1937).



Cement

Chemical Analysis of Cement (Committee C-1).—Study of improved and shorter methods for chemical analysis of cement. Cooperative program for investigation of test for alkali in Portland cement in preparation. Study completed of tests for manganese and phosphorus in cement and procedures issued as tentative, see preprint, 1937 Report of Committee C-1.

Concrete

Curing of Concrete (Committee C-9).—Development of a standard laboratory method for the determination of the efficiency of a curing material. No report available.

Structural Clay Tile

***Capping Structural Clay Tile** (Committee C-15).—Investigation of methods of capping structural clay tile, comparisons to be obtained between various types of filling for the recesses of bonding tile as well as between different materials for capping. Tests carried out at Rensselaer Polytechnic Institute. See preprint, 1937 Report of Committee C-10.

Fire Tests

***Studies of Size of Samples for Fire Tests of Materials and Construction** (Committee C-5).—Scope of studies includes (1) inquiry into the effect of size of samples on test results; (2) what types of information can be obtained on samples smaller than the standard size for given types of construction; (3) under what conditions information on load-carrying ability can be obtained from temperature measurements without load application; and (4) the necessary distribution of thermocouples and other measuring appliances to obtain reliable results. Data obtained now being studied looking toward revision of the standard specifications for fire tests of building construction and materials, see preprint, 1937 Report of Committee C-5.

Refractories

Cold Crushing of Fire-Clay Brick (Committee C-8).—Investigation of crushing strength of fire-clay brick in three directions, namely, flat, on edge and endwise, to obtain data for developing a cold-crushing test. Flexural strength and porosity also determined in order to study what relation, if any, exists between these properties. Methods of test for cold crushing strength and modulus of rupture of refractory brick and shapes issued as tentative, see preprint, 1937 Report of Committee C-8.

Paint and Varnish

Physical Properties of Paint Materials (Committee D-1).—Study of the physical properties connected with paints and paint materials. Viscosity and plasticity of paints, color and optical properties of paints and paint materials have been considered. Present work on study of "gloss" includes (1) preparation of a precise scientific definition of gloss that will be clearly understood and of use commercially, (2) investigation of the relative merits of all instruments and apparatus that are commercially available, upon which satisfactory gloss determinations can be made, and (3) to obtain information and data for the development of a satisfactory gloss specification and method of test, see *Proceedings*, Vol. 36, Part I, p. 364 (1936). Revised method of test for spectral apparent reflectivity of paints issued as tentative, see preprint, 1937 Report of Committee D-1.

Tests of Bituminous Coatings for Underground Pipe Protection (Committee D-1).—Substantially as covered by title, particularly the development of satisfactory test for adhesion and a method of testing the durability of these and other paint coatings, and data based on such tests. For statement on principles of testing paints and combinations of paints on steel panels, see *Proceedings*, Vol. 35, Part I, p. 322 (1935). Data being collected on impact tests and durability of bituminous primers under alternate immersion and exposure to the weather, see preprint, 1937 Report of Committee D-1.

Properties and Tests of Varnishes (Committee D-1).—Studies of the physical and chemical properties of varnishes including tests for adhesion, color, method for determining reactivity of varnishes, study of the drying time and methods for measurement, methods of evaluating failure of varnishes upon exposure and effects of temperature, humidity and other factors upon physical properties of varnishes. Procedures developed for skinning test, alkali resistance and determining acid number of oleo-resinous varnishes, see *Proceedings*, Vol. 35, Part I, pp. 319 and 887 (1935). For current progress, see preprint, 1937 Report of Committee D-1.

Naval Stores (Rosin)

Properties and Tests for Rosin (Committee D-17).—Study, development and standardization of following tests for rosin: viscosity, crystallization, size-making value and alum test, acid and saponification number, unsaponifiable matter, and darkening and volatile matter upon heating. Study of methods for determining crystallization, tendency of rosin reported, see *Proceedings*, Vol. 34, Part I, p. 546 (1934). Data so far obtained in applying falling-ball viscosity method to rosin included in 1935 report, see Vol. 35, Part I, p. 477 (1935). Tests in progress on determinations of ash in rosins, and the extent of darkening on heating of rosin for varnish making. Methods of test for acid number and saponification number of rosin issued as tentative, see preprint, 1937 Report of Committee D-17. Report also includes data in support of the test methods.

Petroleum Products and Lubricants

Melting Point of Grease (Committee D-2).—Study of the pressure-flow relationship of greases, including the consistency of very soft greases, development of laboratory method indicative of point at which gear lubricants might channel in service, and improvement in grease worker for penetration method. Proposed method of test for dropping point of lubricating greases published as information, see 1937 reprint pamphlet, "A.S.T.M. Standards on Petroleum Products and Lubricants."

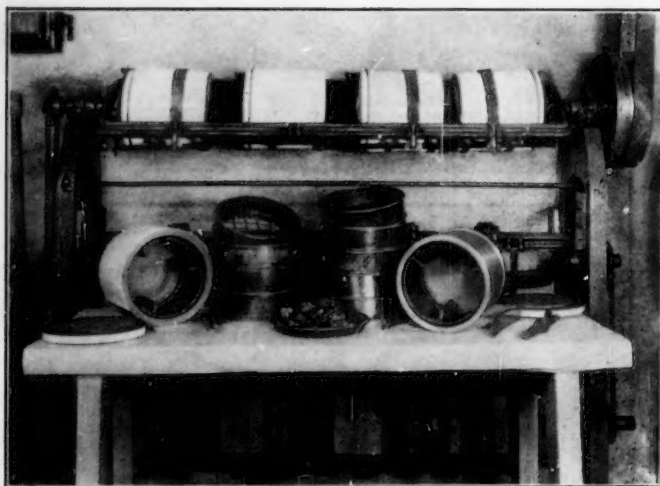
Kinematic Viscosity Tests (Committee D-2).—Study of methods for determining kinematic viscosity of any petroleum product or lubricant which is a true viscous liquid at the temperature of the test. Methods using the suspended level and modified Ostwald instruments, and a method for conversion of kinematic viscosity to Saybolt Universal viscosity, issued as tentative; also a brief paper by C. E. Headington and J. C. Geniesse in connection with the new method for viscosity conversion, see 1937 reprint pamphlet, "A.S.T.M. Standards on Petroleum Products and Lubricants."

Corrosion Tests of Lubricating Oils (Committee D-2).—Substantially as covered by title. Present program involves development of laboratory test methods which will correlate with road service to determine whether engine oil or hypoid-gear lubricant is corrosive or will become corrosive in service. Consideration being given to laboratory corrosion tests in which the bearing metal is heated in the lubricant under test at an elevated temperature for a definite period of time and laboratory bearing tests in which bearings are operated at loads, speeds and temperatures comparable to service. Tests completed on six oils. Program for future work being developed. No report available.

***Tests of Plant Spray Oil** (Committee D-2).—Substantially as covered by title. Method of test for distillation of plant spray oils issued as tentative and a test for unsulfonated residue of plant spray oils published as information; see 1937 reprint pamphlet, "A.S.T.M. Standards on Petroleum Products and Lubricants."

***Vapor Pressure of Petroleum Products** (Committee D-2).—Study of two existing test procedures (Methods D 323 and D 417) for vapor pressure (Reid method) to determine (1) whether 28 lb. is the proper upper limit of application of Method D 417, (2) if Method D 417 is practical for use in natural-gasoline plant laboratories, and (3) what vapor-pressure method should be prescribed for natural gasolines above the upper limit of application of Method D 417. Extensive tests resulted in preparation of single method of test, see 1937 reprint, "A.S.T.M. Standards on Petroleum Products and Lubricants."





Tumbler Test Apparatus for Friability of Coal

Bituminous Materials

***Tests for Water-Soluble Salts in Asphalt-Salt Mixtures** (Committee D-4).—Substantially as covered by title. A series of cooperative tests on asphalt-salt mixtures conducted during past year. For procedure used and results obtained see preprint, 1937 Report of Committee D-4.

Tests of Bituminous Emulsions (Committees D-4 and D-8).—Investigations of testing methods for bituminous emulsions for use on roads and also emulsions used for waterproofing generally, whether vertical or horizontal, and with or without membranes. General test procedures issued as tentative, see *Proceedings*, Vol. 36, Part I, p. 880 (1936). Cooperative test program resulted in development of new test procedures for resistance to water action and the ability to withstand flow at elevated temperatures, see *Proceedings*, Vol. 37, Part I (1937).

Accelerated Weathering Tests of Bituminous Roofing Materials (Committee D-8).—Study of an electrical accelerated weathering test applicable to roofing. Draft of proposed method published as information, see *Proceedings*, Vol. 33, Part I, pp. 379, 381 (1933). Current report contains description of the weathering cycle now generally used in the proposed accelerated test, see preprint, 1937 Report of Committee D-8.

Tests for Mineral Surfacing Materials on Roofing (Committee D-8).—Development of tests designed to test the effectiveness of imbedding of granular mineral surfacing in the asphalt coating of the weather surface of asphalt-prepared roofing and shingles. Series of cooperative tests with three types of machines described in paper by H. W. Greider and G. A. Fasold on "A Comparison of Abrasion Test Methods for Imbedding of Granular Mineral Surfacing on Asphalt Roofing," see *Proceedings*, Vol. 36, Part I, p. 453 (1936). Methods of test for sieve analysis of granular and non-granular mineral surfacing for asphalt roofing and shingles published as tentative this year. Results of cooperative test studies of the methods also presented; see preprint, 1937 Report of Committee D-8.

Analytical Methods for Bituminous Saturated Fabrics for Waterproofing (Committee D-8).—Study of improved methods for testing felted and woven fabrics for use in waterproofing and roofing, including the determination of the saturants in felts and fabrics saturated with coal-tar materials containing free carbon; also those saturated with coal tar and surfaced with talc, mica, or similar materials. As result of cooperative series of tests, modifications of the test procedures covering roofing and shingles have been prepared; see preprint, 1937 Report of Committee D-8.

Gaseous Fuels

Tests for Gases Used as Commercial Fuels (Committee D-3).—Development and formulation of standard methods of procedure for the following determinations of gaseous fuels: calorific value,

specific gravity, impurities, water vapor content, complete analysis or chemical composition, collection and measurement of samples, see preprint, 1937 Report of Committee D-3.

Coal and Coke

Sampling of and Tolerances for Coal (Committee D-5).—A series of sampling experiments to test the accuracy of the present standard method of collecting and reducing gross samples of coal. Experiments of both hand and machine sampling methods on a number of different coals varying in size, and containing different amounts of impurities. Study has resulted in proposed revisions of the standard methods of sampling coal to provide a procedure for the reduction of gross samples by means of mechanical crushers and riffle samplers; see preprint, 1937 Report of Committee D-5.

Agglutinating Value of Coal (Committee D-5).—Study of laboratory test for obtaining information regarding the coking and caking properties of coal. Proposed draft of a method which is an approximate measure of that material in coal which fuses and becomes plastic on heating published as information, see *Proceedings*, Vol. 34, Part I, p. 457 (1934). Technique of test procedure being improved, also silicon carbide (carborundum) being investigated to determine its suitability for use as an inert material in the method, see preprint, 1937 Report of Committee D-5.

Pulverizing Characteristics of Coal (Committee D-5).—Investigation of laboratory methods to determine comparative pulverizing characteristics of different coals in connection with their commercial pulverization as powdered coal. As a result of extensive studies two test methods have been developed for grindability of coal, namely, the ball-mill and Hardgrove-machine methods. Further investigative work has resulted in extensive revision of the two methods, see preprint, 1937 Report of Committee D-5.

Friability of Coal (Committee D-5).—Investigation of method for determining resistance of coal to breakage on handling. Methods of drop shatter test and of tumbler test for coal published as tentative this year; see preprint, 1937 Report of Committee D-5.

***Ignitability of Coal and Coke** (Committee D-5).—Investigation of laboratory tests for determination of ignition temperatures of fuels. Work just undertaken, no report available.

Electrical Insulating Materials

Tests of Insulating Sheets, Tubes and Rods (Committee D-9).—The following studies of laminated sheet insulating materials are being conducted: Method for determining compressibility as a function of time; methods of measuring the modulus of elasticity in compression; the effect of temperature variations on water absorption; effect of humidity on dielectric strength and on flexural strength; impact fatigue tests, arc resistance, hardness tests, punching quality and insulation resistance tests; also methods of test for flammability and heat resistance. Indentation hardness test using Rockwell tester developed. For current progress see preprint, 1937 Report of Committee D-9. Specifications for laminated phenolic materials for radio use issued as tentative, see *Proceedings*, Vol. 37, Part I (1937).

Tests of Insulating Papers and Fabrics (Committee D-9).—Investigation and development of methods and apparatus for testing insulating papers, as follows: Tests for moisture in impregnated cable paper; acidity tests; oil penetration; air resistance of insulating paper and effect of humidity on dielectric strength of varnished cambric. Methods for thickness and folding endurance developed; also specifications and tests for varnished cloth tape and flexible tubing. For current progress see preprint, 1937 Report of Committee D-9.

Tests of Insulating Mineral Oils (Committee D-9).—Development of tests primarily applicable to circuit breaker oils, such as the determination of gas formed during arc-over, measurement of carbon formed and precipitated during arc-over, and a test for amount of water precipitated or emulsified during arc-over; also low-temperature viscosities. Studies of the following tests of insulating oils: Neutralization value of both new and used oils; resistance of insulating oils to oxidation (sludge tests); tests for moisture content

and for saponification value. For summary of four years' work on sludge tests, see paper by F. M. Clark and E. A. Snyder on "Testing for Sludge Formation in Mineral Transformer Oil"; also draft of potentiometric method for neutralization number published as information, see *Proceedings*, Vol. 36, Parts I and II (1936). For current progress see preprint, 1937 Report of Committee D-9.

Tests of Insulating Compounds (Committee D-9).—Investigation of methods of test for solid filling and treating compounds used for electrical insulation, including: Coefficient of expansion; determination of insulation-resistance temperature characteristics; specimens and tests for dielectric strength; also viscosity tests of high melting asphaltic compounds. Revised dielectric strength procedure published, see preprint, 1937 Report of Committee D-9.

Power Factor and Dielectric Constant of Insulating Materials (Committee D-9).—Development and preparation of test methods for measuring dielectric constant and power factor of liquid insulation and of solid insulating materials. Round-robin tests under way dealing with power factor measurements of liquid insulation. A special test cell has been constructed to be used by the cooperating laboratories. Work on power factor of solid insulation is in progress, and five laboratories have completed their measurements. Complete revision of standard methods of test for resistivity of insulating materials published as tentative, see preprint, 1937 Report of Committee D-9.

Tests for Properties of Glass for Electrical Purposes (Committee D-9).—Comprehensive study of mechanical and electrical tests for evaluating the characteristics of glass for electrical insulating purposes. Mechanical and physical properties to be studied include: tensile, compressive, flexural and shearing strength, torsion, impact, elasticity hardness, thermal expansion and shock, weathering and corrosion, water solubility, chemical durability, and visibility. Electrical properties to be considered include: dielectric constant, power factor, volume resistivity as function of temperature, surface resistivity as function of humidity, and previous weathering treatment, dielectric breakdown as function of frequency, of impulse, of thickness, and of temperature. Methods of testing pin-type lime glass insulators issued as tentative; see reprint of method; also *Proceedings*, Vol. 37, Part I (1937).

Rubber Products

Life Test for Rubber Products (Committee D-11).—Accelerated aging tests of various types of rubber compounds in comparison with natural aging of the same samples. Methods of test for accelerated aging of vulcanized rubber developed, see *Proceedings*, Vol. 35, Part I, p. 1167 (1935). Method for air pressure heat test of vulcanized rubber published as tentative; see preprint, 1937 Report of Committee D-11.

***Tests of Liquid Rubber Products** (Committee D-11).—Formulation of standard methods of test for the evaluation of rubber cements and rubber latex. Work on cements will include tests for viscosity and determination of total solids; and on latex, methods will be investigated for color, total solids, dry rubber content, ammonia, and hydrogen ion concentration. Cooperative series of tests planned; see preprint, 1937 Report of Committee D-11.

Textile Materials

Methods of Testing Raw Cotton (Committee D-13).—Based upon fundamental research of cotton fiber quality such as that of the cotton fiber laboratories of the U. S. Bureau of Agricultural Economics, on studies of length, strength, fineness, maturity and color of raw cotton, work is being undertaken on specifications and suitable methods of measurement. General test methods for determining length, length distribution, fineness immaturity count and strength of cotton fibers developed; see compilation of "A.S.T.M. Standards on Textile Materials" (September, 1937).

Tests of Rayon and Rayon Fabrics (Committee D-13).—Studies of tension test for wet specimens, cloth fraying test, washability or launderability test; also methods to determine pulling at seams, slippage of fabrics, and oil and moisture contents of oiled rayons. Methods developed for identification of different types of rayon, for

strength of rayon woven fabric when wet, for shrinkage in laundering and test for slippage of woven rayon broad goods; see compilation of "A.S.T.M. Standards on Textile Materials" (September, 1937). Work under way on developing methods of testing spun rayon fabrics, particularly with regard to wrinkling and bulging; see preprint, 1937 Report of Committee D-13. Symposium on Rayon held October, 1936; for papers presented, see Compilation of "A.S.T.M. Standards on Textile Materials" (September, 1937).

Tests of Wool and Its Products (Committee D-13).—Substantially as covered by title. Present considerations cover methods for determination of shrinkage in grease wool, methods of testing yarn spun from wool mixed with other fibers, and a wear test procedure for pile floor coverings. Method of test for woolen and worsted yarns have been issued; also tests for estimating fineness of wool in loose form, methods for testing pile floor coverings, procedure for estimating scoured content of grease wool, tests for wool felt, test for fineness of wool tops, and methods of testing certain wool and part wool fabrics, see compilation of "A.S.T.M. Standards on Textile Materials" (September, 1937). For current progress, see preprint, 1937 Report of Committee D-13.

***Tests for Bast Fibers and Their Products** (Committee D-13).—Substantially as covered by title. Studies under way on breaking strength, fiber length determination, and numbering of jute yarns. Work recently undertaken, no report available.

Tests for Bleaching, Dyeing and Finishing of Textiles (Committee D-13).—Methods of test developed for fastness of dyed or printed cotton fabrics, and dyed or printed silk or rayon fabrics to laundering or domestic washing, also a test for volumetric determination of small amounts of copper in textiles, see compilation of "A.S.T.M. Standards on Textile Materials" (September, 1937). Consideration being given to methods of test for water resistance, and fastness to light, and a general method for determining the acidity or alkalinity of textiles. See preprint, 1937 Report of Committee D-13.

Soils

***Tests for Soils for Engineering Purposes** (Committee D-18).—Study and formulation of standard methods of procedure for the following tests of soils for engineering purposes: Physical characteristics, compressibility and elasticity, shearing properties, mechanical stability, load capacity of soil in place, bearing capacity of piles, and drainage properties.

Industrial Waters

Methods of Analysis of Industrial Waters (Committee D-19).—Substantially as covered by title. Consideration being given to proposed methods for determination of chloride, calcium, and magnesium ions in waters for industrial uses. Program contemplates tests for determination of silica and dissolved oxygen in water. Proposed methods for the determination of sulfate, hydroxide, carbonate and orthophosphate ions in industrial waters, edited and based upon methods developed by Subcommittee 8 of the Joint Research Committee on Boiler Feedwater Studies, published as information, see special reprint pamphlet, October, 1936. See papers on "Technique in the Determination of Dissolved Oxygen," by T. H. Daugherty; "Determination of Hardness in Water by Direct Titration," by R. T. Sheen and C. A. Noll; "Some Applications of the Polarizing Microscope to Water-Conditioning Problems," by Everett P. Partridge issued in preprint form (1937).

Miscellaneous Subjects

General Study of Methods of Determining Consistency and Plasticity (Committee E-1).—The committee is cooperating with various agencies in the development of suitable standards for rheological properties of materials. Consideration being given to the fundamental conceptions of the definition of viscosity and methods of determining viscosity in absolute units. Symposium on Consistency held this year, consisting of nine papers; available in mimeographed form. Definitions of terms relating to rheological properties of matter published as tentative, see *Proceedings*, Vol. 37, Part I (1937).



New Specifications and Tests Approved by Standards Committee

THE Society's Committee E-10 on Standards at its meeting at Headquarters on August 24 approved for publication as tentative twelve proposed new specifications and test methods recommended by various standing committees, accepted revisions to be incorporated immediately in nine existing tentative standards and approved for publication as tentative changes in four formal standards. A number of these new and revised specifications and tests are considered of unusual importance to the various industries to which they are directly related.

These actions by the Standards Committee are in accordance with the By-laws which provide that in the interval between annual meetings, standing committees may refer recommendations to Committee E-10. This method of approving new tentative standards was set up to expedite the issuance of important items and to take care of urgent cases where committees could not have their various details worked out in time to report at the annual meeting.

A number of new tentative standards in the list which appears below are the result of intensive committee work extending over many months. They will meet definite demands from various parties for standardized requirements.

The new tentative standard covering phenolic laminated sheet for radio applications is the first A.S.T.M. specification for this type of material and the test methods for pin-type soda-lime glass insulators are the first recommendations emanating from the Section on Glass which functions under Committee D-9 on Electrical Insulating Materials.

The newly developed test methods for changes in properties of rubber and rubber-like materials in liquids are considered to be of significance, because no standard of this nature has been available previously. They are expected to fill a long-felt need, and if properly used, should result in the development of comparative data of considerable usefulness.

With the approval of the new specifications and test methods for fineness of wool tops, the Society has established scientific specifications for fineness value of commercial wool products which should result in considerable benefit to the entire worsted industry, Committee D-13 on Textile Materials indicated in its report to the Standards Committee.

All of the new specifications and tests, and revisions will be published in the 1937 *Proceedings*, Part I, and also in the 1937 Book of A.S.T.M. Tentative Standards. As with all of the A.S.T.M. specifications, whether tentative or standard, they will also be available in separate form.

Including the new items listed below, there are now 312 tentative standards and 511 standards, a total of 823.

NEW TENTATIVE STANDARDS

Tentative Specifications for:

- Seamless Carbon-Molybdenum Alloy-Steel Pipe for Service at Temperatures from 750 to 1000 F. (A 206 - 37 T) *Committee A-1 on Steel*
- Seamless Alloy-Steel Pipe for Service at Temperatures from 750 to 1100 F. (A 158 - 37 T) *Committee A-1*
- Rolled Wrought-Iron Shapes and Bars (A 207 - 37 T) *Committee A-2 on Wrought Iron*

- Phenolic Laminated Sheet for Radio Applications (D 467 - 37 T) *Committee D-9 on Electrical Insulating Materials*
- Rubber Gloves for Electrical Workers on Apparatus or Circuits not Exceeding 3000 Volts to Ground (D 120 - 37 T) *Committee D-11 on Rubber Products*
- Insulated Wire and Cable: Heat-Resisting Rubber Compound (D 469 - 37 T) *Committee D-11*
- Fineness of Wool Tops (D 472 - 37 T) *Committee D-13 on Textile Materials*

Tentative Methods of:

- Testing Films Deposited from Bituminous Emulsions (D 466 - 37 T) *Committee D-8 on Bituminous Waterproofing and Roofing Materials*
- Testing Pin-Type, Lime Glass Insulators (D 468 - 37 T) *Committee D-9*
- Testing Rubber Hose (D 380 - 37 T) *Committee D-11*
- Testing Rubber Insulated Wire and Cable (D 470 - 37 T) *Committee D-11*
- Test for Changes in Properties of Rubber and Rubber-Like Materials in Liquids (D 471 - 37 T) *Committee D-11*

REVISIONS IN EXISTING TENTATIVE STANDARDS

Tentative Specifications for:

- Alloy-Steel Bolting Materials for High-Temperature Service from 750 to 1100 F., Metal Temperatures (A 193 - 37 T)
- Paving Brick (C 7 - 37 T)
- Glazed Building Units (C 126 - 37 T)
- Insulated Wire and Cable: Class AO, 30 per cent Hevea Rubber Compound (D 27 - 37 T)
- Insulated Wire and Cable: Performance Rubber Compound (D 353 - 37 T)

Tentative Methods of:

- Testing Sheet and Plate Materials Used in Electrical Insulation (D 229 - 37 T)
- Quantitative Spectrochemical Analysis of High Grade Pig Lead (E 25 - 37 T)
- Quantitative Spectrochemical Analysis of Zinc Alloy Die Castings for Minor Constituents and Impurities (E 27 - 37 T)

Tentative Definition of:

- Terms Relating to Rheological Properties of Matter (E 24 - 37 T)

TENTATIVE REVISIONS OF STANDARDS

Standard Specifications for:

- Boiler and Firebox Steel for Locomotives (A 30 - 33)
- Iron and Steel Chain (A 56 - 30)
- Staybolt Wrought Iron, Solid (A 84 - 36)
- Staybolt Wrought Iron, Hollow Rolled (A 86 - 36)

Standard Method of:

- Test for Softening Point of Tar Products (Cube-in-Water Method) (D 61 - 24)

List of Standards Sent on Request

A COMPLETE List of A.S.T.M. Standards and Tentative Standards as of September, 1937, has recently been published in the form of a 36-page pamphlet. All of the 823 standard and tentative A.S.T.M. specifications, test methods, definitions, recommended practices, etc., are listed in the pamphlet under five main subdivisions according to the various committee classifications in the A, B, C, D and E groups. Standards in each classification are grouped according to the materials to which they apply, each group being subdivided under specifications, methods of testing, recommended practices and definitions. An alphabetical table of contents is of considerable assistance in locating standards on a specific subject. Copies of this list are available without charge and can be obtained by writing the Society Headquarters.



Many New Standards on Construction Materials

MANY of the specifications and tests formally adopted in 1937 as A.S.T.M. standards and a number of the proposed standards approved for publication as tentative cover numerous construction materials which are in relatively wide usage in building construction. Many of the materials covered are used in such structures as buildings, highways, dams, pipe lines and similar projects.

There is a quite definite trend toward the use of recognized standard specifications in the purchase and use of materials, and many professions concerned with the building industry such as architects, designing and construction engineers, building code officials, etc., are stressing more than ever before the necessity for using materials of specified quality. The steadily increasing use of standards issued by the Society is definite evidence of the wider appreciation of their value and utility.

As Doctor Fieldner has pointed out, the A.S.T.M. standards are *competent* because they are based on the best commercial practice, on adequate scientific research and on sound engineering judgment.

They are *unbiased* because each standing committee charged with the development or supervision of standards having a commercial bearing is made up of approximately equal representation of producing, consuming and general interests, the latter including engineering consultants, schools, independent research institutes, governmental technical agencies.

A.S.T.M. standards are *widely applicable* because they are formulated by committees whose members are carefully selected from all the different industries and technical groups which have occasion to use the standards. They are the result of a broad point of view over the entire field of engineering materials. They are *authoritative* because they have behind them a great Society organized 35 years ago for the specific purpose of "The promotion of knowledge of the materials of engineering and the standardization of specifications and the methods of testing."

A list of new standards which should be of particular interest to those directly concerned with the building construction field, including building code officials, contractors, materials engineers and others, is given below. Anyone desiring a complete list of the standards and tentative standards issued by the Society can obtain a copy by writing to Society Headquarters.

STANDARD SPECIFICATIONS ADOPTED IN 1937
(These have been previously published as tentative)

Standard Specifications for:

- Fabricated Steel Bar or Rod Mats for Concrete Reinforcement (A 184 - 37)
- Welded Steel Wire Fabric for Concrete Reinforcement (A 185 - 37)
- Reinforced-Concrete Culvert Pipe (C 76 - 37)
- Timber Piles (D 25 - 37)
- Structural Wood Joist and Plank, Beams and Stringers, and Posts and Timbers (D 245 - 37)

Standard Methods of:

- Testing Brick (Modulus of Rupture, Compressive Strength, Absorption) (C 67 - 37)
- Panel Test for Resistance to Thermal and Structural Spalling of Super Duty Fireclay Brick (C 122 - 37)

- Test for Determination of Amount of Material Finer than No. 200 Sieve in Aggregates (C 117 - 37)
- Test for Determination of Voids in Aggregate for Concrete (C 30 - 37)

NEW TENTATIVE SPECIFICATIONS

(Approved in 1937. Certain of these were issued previously but were extensively revised this year)

METALLIC MATERIALS

Tentative Specifications for:

- Rolled Wrought-Iron Shapes and Bars (A 207 - 37 T)
- Iron and Steel Filler Metal (Arc-Welding Electrodes and Gas-Welding Rods) (A 205 - 37 T)
- Zinc-Coated (Galvanized) Iron or Steel Farm-Field and Railroad Right-of-Way Wire Fencing (A 116 - 37 T)
- Zinc-Coated (Galvanized) Iron or Steel Barbed Wire (A 121 - 37 T)

NON-METALLIC MATERIALS

Tentative Specifications for:

- Paving Brick (C 7 - 37 T)
- Sewer Brick (Made from Clay or Shale) (C 32 - 37 T)
- Building Brick (Made from Clay or Shale) (C 62 - 37 T)
- Concrete Units for Non-Load-Bearing Masonry, and Methods of Test for (C 129 - 37 T)
- Lightweight Aggregate for Concrete (C 130 - 37 T)
- Fire-Retardant Properties of Wood for Scaffolding and Shoring (C 132 - 37 T)
- Asphalt for Damp-proofing and Waterproofing (D 449 - 37 T)
- Coal-Tar Pitch for Roofing, Damp-Proofing and Waterproofing (D 450 - 37 T)
- Asphalt Cap Sheet Surfaced with Coarse Mineral Granules (D 371 - 37 T)
- Creosote for Priming Coat with Coal-Tar Pitch in Damp-Proofing and Waterproofing (D 43 - 37 T)
- Standard Sizes of Coarse Aggregate for Highway Construction (D 448 - 37 T)

Tentative Methods of Test for:

- Abrasion of Coarse Aggregate by Use of the Los Angeles Machine (C 131 - 37 T)
- Compressive Strength of Portland-Cement Mortars (C 109 - 37 T)
- Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate (C 88 - 37 T)
- Cold Crushing Strength and Modulus of Rupture of Refractory Brick and Shapes (C 133 - 37 T)
- Abrasion of Gravel by Use of the Deval Machine (D 289 - 37 T)
- Sieve Analysis of Granular Mineral Surfacing for Asphalt Roofing and Shingles (D 451 - 37 T)
- Sieve Analysis of Non-Granular Mineral Surfacing for Asphalt Roofing and Shingles (D 452 - 37 T)
- Asphalt Roll Roofing, Cap Sheets, and Shingles (D 228 - 37 T)
- Coarse Particles in Mixtures of Asphalt and Mineral Matter (D 313 - 37 T)

Offers of Papers for 1938 Meeting

COMMITTEE E-6 on Papers and Publications in anticipation of developing the program for the 1938 Annual Meeting at Chalfonte-Haddon Hall, Atlantic City, is desirous that members of the Society and others who have in mind submitting offers of technical papers should send these offers to Society Headquarters well in advance of the February meeting of the committee. All offers must be accompanied by a summary which should make clear the intended scope of the paper and indicate features that in the opinion of the author will justify its inclusion in the annual meeting program. Suitable blanks to be used in transmitting the necessary information will be sent promptly on request.



BULLETIN

October, 1937 . . . Page 9

Bituminous Practice on Western Highways¹

by J. E. Buchanan²

THE use of asphaltic crude oil and liquid asphaltic residual oil on road surfaces was begun in the western part of the United States about 1898, but due to loose construction technique and inadequate maintenance, such surfaces lost public popularity as automobile traffic increased. Pavements of the heavier type which remained smooth received public encouragement, but only the heavy traffic roads adjacent to the larger cities were so paved. In 1923 the Oregon State Highway Commission started experimental work with liquid asphaltic materials which culminated in the present extensive use of low-cost bituminous surfaces in the western states. At present, low-cost bituminous surfaces are generally used on new construction as a first stage development, to be improved as traffic demands increase and as funds become available. Coincident with the recent rapid development of the low-cost surface there has also been marked development in bituminous macadam and asphaltic concrete practice.

MATERIALS

Aggregate:

Generally speaking the western area affords abundant aggregate of high quality. Ledge rock predominates in some localities; gravel and sand predominate in others; and in some cases both are available. The prevalence of hard, tough extrusive igneous rock in the Columbia River lava plateau of the Pacific Northwest has been a factor in the development and extensive use of penetration macadam construction in that area.

Asphaltic Materials:

All asphaltic materials used in the Pacific Coast states are refined from California crude oils. Construction practices and specifications have been developed in terms of these materials. Western practice generally employs less asphalt than does similar construction in other parts of the United States using asphaltic materials from other sources. The asphaltic materials commonly used in the West are shown in Table I.

FOUNDATIONS

During the early development of low-cost bituminous surfaces, foundations were not given proper consideration, and many failures resulted, but out of these experiences definite and reliable design and construction methods were evolved based on the principles of stabilization by drainage, by compaction at optimum moisture content, by proper gradation of particles, and by control of physical characteristics.

Natural Foundation:

Most western states employ soil technology in locating, designing and constructing the natural foundation with the

common objective of realizing the maximum possible load resistance at the subgrade.

Base:

Where the minimum support value of the subgrade is high, a base 3 or 4 in. thick is constructed of crushed rock or crushed gravel, screened gravel or water-bound macadam. Particular attention is paid to the grading and to the physical properties of the fines in these bases.

Where the natural foundation consists of capillary silts and clays whose minimum support value is low, and in regions subject to freezing, it is customary to build bases from 6 in. to 18 or 24 in. thick. The lower portion of such bases is frequently a selected local material such as disintegrated granite, talus rock, pit-run gravel, sand, etc. (see Fig. 1(a)). The upper 3 to 6 in. is usually constructed to very high standards. Some states favor water-bound macadam. Other states employ a plant-mixed crushed material which is proportioned by weight and mixed with its optimum moisture content. A two-bin separation is used with division on 1/4-in. square opening. Batches are distributed on the roadway by spreader boxes followed by blading and rolling (see Fig. 1(b)). All states exercise close control over grading and physical properties of base materials to insure stability and high minimum load resistance. It is almost universal practice to construct all base courses full width of roadway. Trench construction has been abandoned except on stable subgrades.

While there is no extensive use of stabilization of bases or natural foundation materials by bituminous or other materials, interest in the possibilities presented by emulsified asphalt is rapidly spreading. A number of projects have been constructed throughout the West and performance is being observed.

An asphalt membrane seal is being employed to some extent on subgrades of capillary soils. This consists of one application of 150 penetration asphalt at a rate of 0.7 gal. per sq. yd. which is spread at a temperature of 300 to 400 F. This seal is then covered with sufficient sand, screenings or pea gravel so that the membrane will not be broken during construction of base course.

BITUMINOUS SURFACES

When available funds are limited and when immediate and anticipated near-future traffic is light, a low-cost surface treatment less than 1 in. thick is provided. For intermediate traffic conditions a bituminous surface of penetration macadam, roadmix or plantmix from 1 to 3 in. thick is provided. For heavy traffic, penetration macadam, plantmix and asphaltic concrete surfaces from 3 to 7 in. thick are used.

Surface Treatments:

The simplest type of surface treatment consists of a prime coat of asphaltic material applied at approximately 1/4 gal. per sq. yd. to a base which has been smoothed, compacted and cleaned. This prime is allowed to penetrate and cure following which another spread of asphaltic material at the same rate is made, covered with mineral aggregate and rolled.

¹ Presented at the Fortieth Annual Meeting, Am. Soc. Testing Mats., New York City, June 28-July 2, 1937.

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Discussion intended for publication is of course subject to review by the Committee on Papers and Publications. Address all communications to Society Headquarters.



TABLE I.—ASPHALTIC MATERIALS.

LIQUID ASPHALTIC MATERIALS					
	SC-1	SC-1A	SC-2	SC-3	SC-4
GENERAL REQUIREMENT					
The material shall meet the following requirements.					
Water and sediment, per cent.	not over 2	not over 2	not over 2	not over 2	not over 2
Flash point (Cleveland open cup), deg. Fahr.	more than 150	more than 175	more than 200	more than 200	more than 250
Furol viscosity at 77 F.	20 to 150	40 to 100			
Furol viscosity at 122 F.			200 to 320		
Furol viscosity at 140 F.				150 to 300	350 to 550
Distillation, per cent by volume:					
Total distillate to 437 F.		not over 3	not over 2	not over 2	not over 2
Total distillate to 600 F.		not over 25	not over 15	not over 10	not over 8
Total distillate to 680 F.	not over 50	not over 30	not over 25	not over 20	not over 18
Tests on residue from distillation:					
Float at 122 F.	not over 50	not over 50	more than 25	more than 25	more than 25
Soluble in Carbon Disulfide, per cent.	more than 99.0	more than 99.0	more than 99.0	more than 99.0	more than 99.0
	MC-1	MC-2	MC-3	MC-4	MC-5
GENERAL REQUIREMENT					
The material shall be free from water and shall meet the following requirements.					
Flash point (open Tag), deg. Fahr.		more than 150	more than 150	more than 150	more than 150+
Furol viscosity at 77 F.	40 to 150	150 to 250	300 to 500	500 to 800	
Furol viscosity at 140 F.					170 to 280
Furol viscosity at 180 F.					
Distillation, per cent by volume:					
Total distillate to 437 F.	not over 10	not over 2	not over 2	not over 1	not over 1
Total distillate to 600 F.	more than 25	10 to 20	8 to 20	not over 16	not over 14
Total distillate to 680 F.	not over 50	not over 27	not over 25	not over 25	not over 20
Tests on residue from distillation:					
Penetration 77 F., 100 g., 5 sec.	70 to 300	100 to 300	100 to 300	100 to 300	100 to 300
Ductility at 77 F.	more than 60	more than 60	more than 60	more than 60	more than 60
Soluble in Carbon Disulfide, per cent.	more than 99.5	more than 99.5	more than 99.5	more than 99.5	more than 99.5
	RC-1	RC-2	RC-3	RC-4	
GENERAL REQUIREMENT					
The material shall be free from water and shall meet the following requirements.					
Flash point (open Tag), deg. Fahr.		more than 80	more than 80	more than 80	more than 80
Furol viscosity at 122 F.		80 to 160	200 to 400		
Furol viscosity at 140 F.				275 to 400	700 to 1400
Distillation, per cent by volume:					
Total distillate to 374 F.		more than 5			
Total distillate to 437 F.		more than 12	more than 10	more than 3	more than 0.5
Total distillate to 600 F.		more than 25	more than 20	more than 14	more than 7
Total distillate to 680 F.		not over 40	not over 35	not over 30	not over 25
Tests on residue from distillation:					
Penetration 77 F., 100 g., 5 sec.		60 to 120	60 to 120	60 to 120	60 to 120
Ductility at 77 F.		more than 60	more than 60	more than 60	more than 60
Soluble in Carbon Disulfide, per cent.		more than 99.5	more than 99.5	more than 99.5	more than 99.5

ASPHALT CEMENT	
Use	Penetration
Seal coats	150 to 350
Surface treatments	150 to 350
Penetration macadam	120 to 200
Plantmix	150 to 350
Asphaltic concrete	40 to 150

TABLE II.—BITUMINOUS SURFACE TREATMENTS.

	Quantities, lb. or gal. per sq. yd.	
	Type A	Type B
Prime ^a	0.3	
Asphaltic material ^b	0.125	0.20
Aggregate (¾ by ½ in.)	60	35
Asphaltic material ^b	0.375	0.20
Aggregate (½ in. by 10 mesh)	20	
Aggregate (¾ by ½ in.)		20
Asphaltic material ^c		0.20
Aggregate (¾ by 0 in.)		10

^a Prime is SC-1A liquid asphaltic material.^b Asphaltic material is similar to asphalt cement of 150 to 200 or 200 to 350 penetration designated in the West as liquid asphaltic road material 95+ and 90 to 95.^c Asphaltic material is cutback asphalt RC-3 or quick-setting emulsified asphalt.

Liquid asphaltic material SC-2 is generally used in the dry regions and MC-2 (Table I) is used in the wet regions.

Considerable use is made of a heavier type of surface

treatment which is essentially a double surface treatment involving careful preparation of the base, which is usually, but not always primed. In Table II are summarized two typical surface treatments of this kind. Type B is used in regions of extreme precipitation where experience has demonstrated the necessity of imperviousness which is provided by the double seal. A similar type of double surface treatment is constructed using quick-setting emulsified asphalt throughout.

Roadmix Pavements:

Dense-graded aggregate roadmix is yet the leading type of mix in the West for intermediate traffic conditions. Relatively little use is made of macadam-graded aggregate mixes. Liquid asphaltic materials SC-2, SC-3 and SC-4 are widely used in the arid and semi-arid regions. For wetter locations cutback asphalt MC-2 is preferred. Specifications generally require aggregate to consist principally of angular or crushed particles, but there are also many projects in which the asphaltic material is selected and the mixture designed to utilize aggregate of rounded particles. Recent



TABLE III.—ASPHALTIC CONCRETE.

	Wearing Courses			Leveling Course	Base Course
	A	B	C		
Passing 2½-in. round sieve, per cent.	90 to 100	.....	.....	85 to 95	90 to 100
Passing 1½-in. round sieve, per cent.	75 to 90	95 to 100	.....	70 to 90	65 to 75
Passing ¾-in. round sieve, per cent. ....	.....	78 to 88	.....	.....	50 to 65
Passing ½-in. round sieve, per cent. ....	.....	54 to 64	100	.....	.....
Passing No. 3 sieve, per cent.	40 to 55	36 to 44	90 to 100	36 to 50	30 to 40
Passing No. 10 sieve, per cent.	28 to 36	27 to 35	70 to 90	24 to 36	20 to 30
Passing No. 40 sieve, per cent.	23 to 27	18 to 24	60 to 70	20 to 24	15 to 20
Passing No. 80 sieve, per cent.	15 to 20	6 to 8	35 to 55	10 to 18	8 to 14
Passing No. 200 sieve, per cent.	7 to 11	.....	10 to 20	2 to 6	2 to 4
Added asphalt cement (40 to 70 penetration), per cent.	5 to 6½	5 to 8	9 to 15	4½ to 5½	4 to 5½

construction using a dense-graded screened gravel passing a 1-in. sieve has employed cutback asphalt RC-3 (see Fig. 2). Some use is made of traveling mixing machines for road mixing.

Plantmix Pavements (See Figs. 1 (c) and 3):

Dense-graded aggregate is generally employed. Specifications require two-, three- and four-bin separation and limit moisture content in aggregate to about 1 per cent. Spreading is done both by pulled spreader boxes and by blades from a windrow. Finishing is accomplished by long-wheel-base motor patrols and rolling. There is increasing use of self-powered, mechanical spreading and finishing machines which operate without side forms.

Bituminous materials used are liquid asphaltic materials (SC-3 and SC-4), cutback asphalts (MC-3, MC-4, MC-5, RC-3 and RC-4) and soft asphalt cement of 150 to 200 and 200 to 350 penetration. It is interesting to note that plantmix construction with soft asphalt cement, included in this group, approaches hot-laid asphaltic concrete.

Penetration Macadam (See Fig. 4):

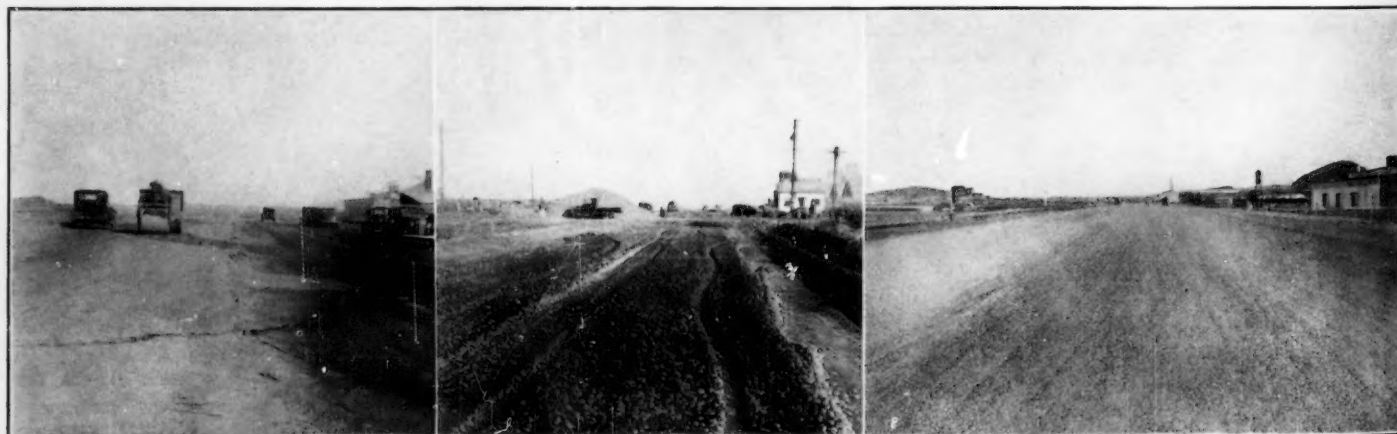
A type of bituminous penetration macadam has been developed in Oregon and is widely used in the Pacific Northwest. The base, which may be either an untreated macadam or an existing pavement, is first shaped, trued and thoroughly cleaned. Then a tack coat of asphalt is applied and immediately covered by base rock using spreader boxes. This course is trued by means of long-wheel-base motor

graders and hand spotting, after which it is lightly rolled and tested with a 10-ft. straight edge. When the course has been smoothed so that the surface variations are less than ¼ in., rolling proceeds until the rock is thoroughly locked. There then follows a second application of asphalt and another layer of base rock, or key rock, depending on the required finished thickness. This and the following courses of rock are spread, hand spotted, trued and rolled as before. Asphalt is applied between each course of rock. The seal coat is placed in two applications to provide a watertight, smooth, non-skid surface.

Asphalt cement of 120 to 150 or 150 to 200 penetration is used for all applications except the second seal treatment in which quick-setting emulsified asphalt or cutback asphalt RC-3 is used. To assist the penetration of the asphalt and to obtain a more even coating of stone with a thinner film of asphalt, a water-soap solution equal to 10 to 15 per cent of the volume of asphalt is forced under pressure into the spray nozzles along with the asphalt. This forms a temporary emulsion which breaks quite rapidly and permits immediate rolling.

A further feature of this construction is the use of long-wheel-base motor patrols equipped with steel-wire broom moldboards. The use of this equipment combined with the process of construction in several lifts results in a very smooth, serviceable pavement with a lower asphalt content than is customary in the usual penetration macadam of the same thickness.

Fig. 1—Highway Approach to San Francisco-Oakland Bay Bridge.



(a) First base course 12 in. thick being constructed of selected local material.

(b) Second base course 6 in. thick being constructed of weight-proportioned crushed rock, plantmixed with optimum moisture.

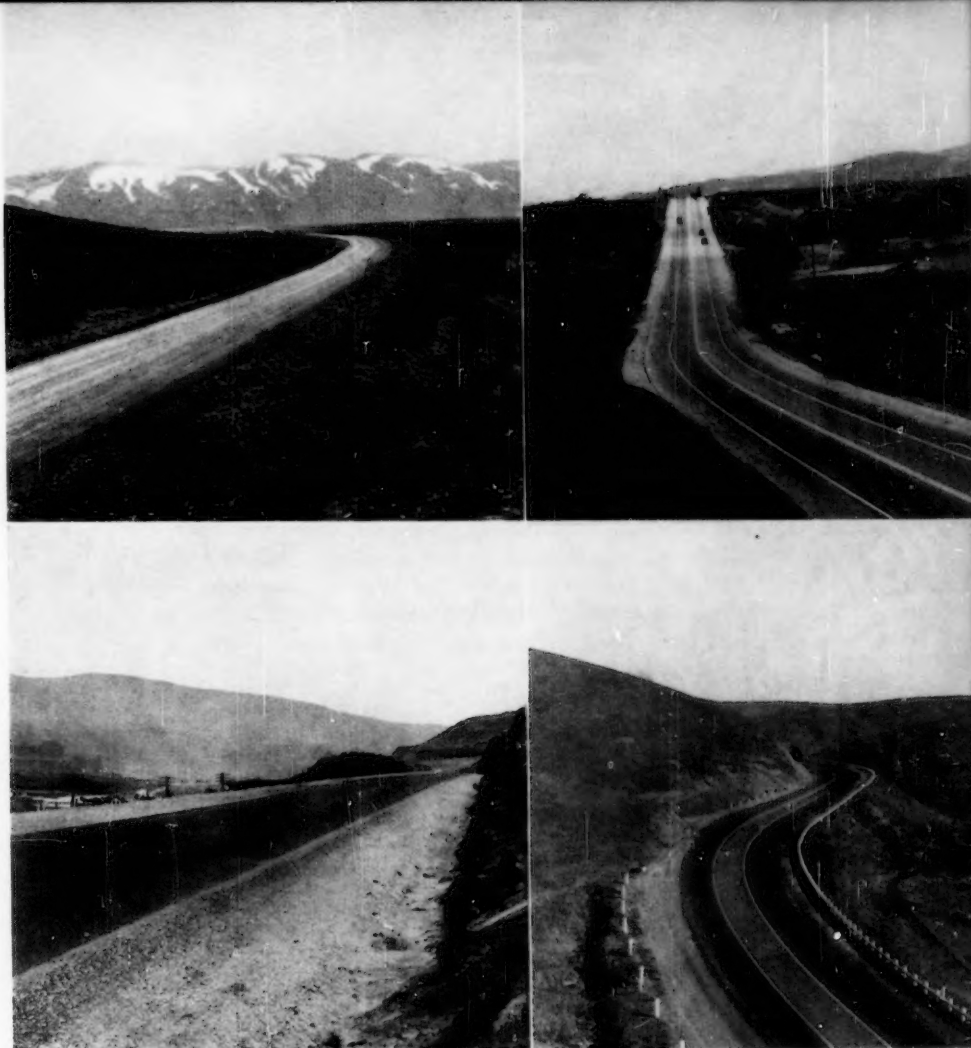
(c) Finished highway surfaced with a 3-in. MC-5 plantmix and sealed with MC-3 and mineral cover (¼" x 10-mesh). Highway consists of two 21-ft. pavements separated by a 10-ft. division strip. Shoulders 9 ft. wide and 10-ft. division strip surface treated with SC-1A, SC-2 and mineral cover.

Fig. 2—Cutback asphalt RC-3 roadmix using dense-graded screened gravel.

Fig. 3—Cutback asphalt MC plantmix on 4-lane highway.

Fig. 4—Penetration macadam pavement. Slope at right is "blow sand" which has been stabilized by a penetration treatment of low-viscosity SC liquid asphaltic material to prevent wind erosion.

Fig. 5—Asphaltic concrete on 3-lane highway.



Asphaltic Concrete (See Fig. 5):

Hot-laid asphaltic concrete is widely used as original pavements and for resurfacing. Representative specifications are given in Table III. Self-propelled mechanical spreading and finishing machines are required in California and are in general use elsewhere. Single spreads of 30 ft. wide are not uncommon.

Seal Coats:

General practice in the West employs a mineral cover for seal coats to provide a non-skid surface and to improve light reflection. Maximum particle size varies, but in general $\frac{1}{2}$ in. is used. Asphaltic materials used are cutback asphalts (MC-3, MC-4, RC-2, RC-3), quick-setting emulsified asphalt, and soft asphalt cement. Where surface texture will not be injured, paint seals of cutback asphalt RC-1 are sometimes used.

SHOULDERS

Shoulders are frequently treated with some form of asphaltic surface treatment. Roadmix and plantmix strips 2 to 4 ft. wide are provided along asphaltic concrete and portland-cement concrete pavements, and the remaining shoulder is given an asphaltic surface treatment. Shoulders adjacent to roadmix and plantmix pavements are often given a simple surface treatment (see Figs. 1 (c) and 5).

DESIGN AND CONTROL OF MIXES

Practically all mixtures are based on prior laboratory in-

vestigations which include some kind of adhesion-tension test, water-asphalt preferential test, swell test, washing test. Several states make stability tests a part of routine design procedure. The Hveem and Hubbard-Field stability tests are most widely used.

Field control of asphalt quantities is often based on a surface-area type of equation which is expressed in terms of aggregate grading. Some use is being made of a briquet stain test both in the laboratory and the field.

PRESENT TRENDS

There is decided interest in the use of softer asphalt in asphaltic concrete. This has been generated by the fine performance of pavements in cities using soft asphalt cement. Cutback asphalts are gradually replacing the slow-curing liquid asphaltic materials except in the arid and semi-arid regions. There is a growing interest in the use of asphaltic material as a binder in bases in lieu of natural fines and clay which have been used heretofore. Some projects have been so constructed in locations where suitable natural filler or binder was not available. The results obtained justify the interest which has developed.

This paper comprises a summary of bituminous practices in a large region which represents extremes of climate and traffic. An attempt has been made to mention only main types and practices. In addition to those included in this paper, examples of practically every other known form of bituminous construction may be found in the West.



Influence of the Elastic Constant of Tension Testing Machines¹

By Rudolf K. Bernhard²

FOR the purpose of this paper, elastic constant is defined as the number of pounds required to deflect the system 1 in. The paper deals with (1) change of equilibrium due to plastic deformation, (2) natural frequency of test machines and accuracy of indication in high-speed tests, (3) discussion of determination of yield point, and (4) further development in test machines.

In the testing of essentially the same material, substantially different results may be obtained depending upon whether the material is tested in a massive or in a light testing machine. Furthermore, the stress-strain diagrams of certain materials indicate peculiar forms near the yield point, which, in many cases, are not dependent on the qualities of the tested material alone.

STATIC SYSTEM

Any hydraulic testing machine may be considered as a system composed of masses and springs (Fig. 1). Masses are the frame of the machine (the crosshead, etc.) M , while springs with a definite elastic constant represent the test specimen, C , and the hydraulic medium, c . At any moment there must be equilibrium between the summation of the elastic forces of the springs and the load on the ram of the machine.

Fig. 1—Schematic Diagram of hydraulic tension testing machine.

Fig. 2—Force-deformation—diagram showing equilibrium between elastic constant of machine and specimen.

Fig. 3—Force-deformation—diagram for different elastic constants.

AD low elastic constant of testing machine.
 AE high elastic constant of testing machine.

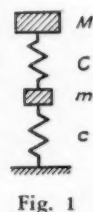


Fig. 1

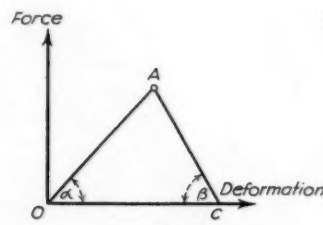


Fig. 2

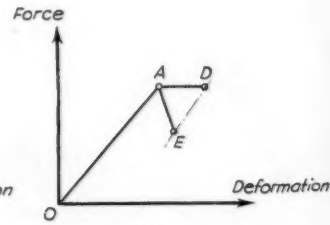


Fig. 3

If deformation (Fig. 2) is plotted against applied force, the line OA shows the load-deformation (stress-strain) diagram of the specimen, and CA the increasing load in the pressure medium. Hence, $\tan \alpha$ represents the elastic constant of the specimen and $\tan \beta$, the elastic constant of the pressure medium. The elastic constants of specimen and pressure medium may differ substantially, even to the extent where the elastic constant of the specimen to that of the medium may have a ratio of 1 to 10.

Assuming a cross-section in the pressure cylinder of about 40 sq. in. and a maximum load of 12,000 lb., the elastic

deformation of the pressure medium becomes approximately 0.12 in., if the height of the liquid in the cylinder is 10 in.; on the other hand, the deformation will be only 0.012 in. if the height of the liquid in the cylinder is about 1 in. Any plastic flow in the specimen will affect the stress-strain diagram, the equilibrium point at A (Fig. 1) being immediately disturbed.

In the case of a testing machine having a low elastic constant, a very small change of load will result with the increase of strain (Fig. 3, line AD); a high elastic constant, on the other hand, will result in a considerable decrease in load with increase of strain (Fig. 3, line AE). At D or E , respectively, when plastic flow ceases, equilibrium between the two elastic forces (specimen and pressure medium) may be restored and the point of equilibrium again rises as soon as the pressure pump starts to force new liquid into the cylinder. It must be borne in mind, however, that with decreasing tension in the specimen, the plastic flow will also cease.

Any rapid flow gradually changes into some kind of creeping flow before equilibrium is finally achieved. Hence, such drop in the load-deformation diagram, due to plastic flow, may be independent, in certain cases, of the quality of the tested materials.

DYNAMIC SYSTEM

The plastic flow or any pressure changes in the cylinder may take place very suddenly, and the indicating device of the testing machine must follow these rapid changes immediately in both coordinates—load and deformation. It is well known that as soon as rapid changes come into consideration, the accuracy of any indicating device depends on the natural period of the whole vibrating system (Fig. 1).

For the 12,000-lb. testing machine mentioned above, the natural frequency is about 160 cycles per second if the medium in the cylinder has a height of 10 in. and is approximately 500 cycles per second if this height is only 1 in. In the second case, the elastic constant of the system will be much higher, as mentioned above.

Any fluctuations during the test having a frequency of more than one-tenth of the frequency of the machine, that is, more than 16 cycles per second, will cause incorrect indications³, assuming for simplicity that only vibrations of a sine form with a small damping factor come into consideration. This indicates that different values for the "upper" and "lower" yield points, independent of the quality of the tested material and due to rapid changes of plastic flow near to these yield points, may be found.⁴

¹Based upon a paper by W. Spaeth appearing in "Archiv für Eisenhüttenwesen," No. 6, December, 1935.

²Consulting Engineer, Baldwin-Southwark Corp., Philadelphia, Pa.

³R. K. Bernhard—New Methods for Dynamical Measuring. Intl. Assn. for Bridge and Structural Engr. Paper read at First Congress, Paris, May 19-25, 1932.

⁴The "upper" yield point may be defined as the highest point of the stress-strain diagram after the elastic limit has been passed, the "lower" yield point as the lowest point of the stress-strain diagram after the above mentioned "upper" yield point has been passed and before the final rise of the stress-strain diagram up to the ultimate strength (Fig. 4).

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EFFECT UPON YIELD POINT DETERMINATIONS

The surplus in tension at the upper yield point is some kind of "delayed" phenomenon. Once plastic flow of the material in the specimen has started, the further shape of the diagram depends substantially upon the character of the test machine. If the elastic constant of the test machine is low (Fig. 5), any lower yield point will be suppressed, as the elongation of the test specimen produced by plastic flow means no decrease in tension for the testing machine itself. A very high elastic constant of the testing machine, however, will produce the well-known fluctuations (leaping effect) shown in Fig. 4.

A similar result will be produced if the test specimen is long and has a low elastic constant, thus causing a heavy drop in the diagram. Consequently, a very short and rigid specimen may indicate no lower yield point at all (Fig. 5).

The conclusion is accordingly reached that the upper and lower yield points are closely associated with the characteristics of the testing machine and are very often independent of the quality of the material, and that the speed of the test and the form of the specimen are in certain cases secondary.

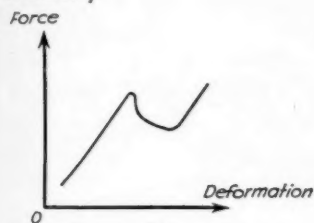


Fig. 4

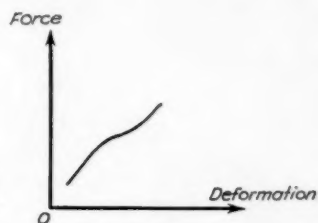


Fig. 5

In some cases, however, the upper and lower yield point may be of particular importance for the structure itself, as in the following three examples:

1. In a pressure vessel, the elastic constant of the vessel and the pressure medium are in close relationship. Keeping in mind that the elastic constant of any liquid is usually much *higher* than the elastic constant of the vessel, any plastic flow in the material of the vessel itself will produce a substantial decrease in the unit pressure of the liquid. Hence, usually no damage will occur in the event of small plastic distortion of the vessel.

2. However, if the pressure vessel is filled with a gas, the elastic constant of the gas being much *smaller* than the elastic constant of the vessel, any plastic flow, due to over-stress, will be taking place under essentially constant pressure and the vessel will almost certainly explode.

3. A flywheel may have a rotating speed high enough to

produce a plastic flow in one of the spokes. In this case, the stress in the spoke will continue to rise due to centrifugal forces and the plastic flow will increase. Under these conditions, no lower yield point may be developed.

NEW TYPES OF TESTING MACHINES

These examples indicate the desirability of developing new types of testing machines. Two distinct types of testing machines are suggested:

1. One type of machine would have a very small elastic constant. Irrespective of plastic flow, the specimen would continue to be under the same load, and any lower yield point will be suppressed. Quick changes of the load cannot occur; hence, the indicating device need not be designed for high frequencies. For indicating elongation or pressure, the routine instruments are sufficient.

Testing machines with small elastic constants may be constructed either by connecting the cylinder with a small air chamber or connecting in series the specimen, a spring having a small elastic constant, and the rods of the testing machine. This arrangement has the advantage that it cuts off from the masses of the testing machine any high frequencies due to plastic flow.

2. The second type of testing machines would have a very high elastic constant. This type of machine should be of

Fig. 4—Force-deformation—diagram with a high "upper" and low "lower" yield point. The testing machine has a high elastic constant and the test specimen a low elastic constant.

Fig. 5—Force-deformation—diagram with a high "upper" and no "lower" yield point. The testing machine has a low elastic constant and the test specimen a high elastic constant.

extremely rigid construction, and the pressure medium in the cylinder should have but small height at the beginning of the test. (Mercury, instead of water, will probably produce better results as it has a much higher elastic constant.) In this case, even the most minute flow will be indicated instantly, assuming that the indicating device can detect and indicate the slightest changes; that is, that it has a high natural frequency. The ordinary types of manometer or pendulum apparatus or tensometer are not sufficient.

Assuming the above-mentioned conditions, the stress-strain diagram will show any plastic flow, including the smallest and greatest amplitudes (fluctuations), which occasionally might drop as low as zero.

Studies with such testing machines would throw more light on the phenomena which occur during plastic flow, helping to interpret the significance of the upper and lower yield point.

Papers on Paint and Varnish

AT THE main session of the series of meetings held by Committee D-1 on Paint, Varnish, Lacquer, and Related Products during the recent annual meeting in New York City, five short papers were presented as follows:

Development of Hiding Power Test Methods—D. L. Gamble, Research Division, New Jersey Zinc Co.
Accelerated Testing of House Paints—C. H. Rose, Chemist, National Lead Co.

Five Papers Presented at D-1 Meeting

Accelerated Testing of Paints for Iron and Steel—J. C. Moore, Superintendent, Paint Plant, Sinclair Refining Co.
A Proposed Test for Determining the Reactivity of Varnishes and Paint Liquids—Sidney Werthan, New Jersey Zinc Co.
Determining the Depth of Color in Varnishes—G. G. Sward, Chemist, National Paint, Varnish and Lacquer Assn.

This policy of including papers was an innovation on the part of the committee and apparently met with con-



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siderable favor. The essential portions of the first two papers will be covered in the annual report of the committee as it appears in the *Proceedings*, but since the other items will not be included and because they undoubtedly will be of interest to many members, they are to be published in the BULLETIN. Two of the papers including the proposed test procedure for determining the reactivity of varnishes and paint liquids appear below. The other, by J. C. Moore, will be in the December issue.

A Proposed Test for Determining the Reactivity of Varnishes and Paint Liquids

In April, 1935, Group 1 of Subcommittee IX on Varnish undertook to develop a reactivity test for varnishes and paint liquids. A partial survey disclosed that tests for determining this property were being used with reasonable success by a large number of paint laboratories. The detailed methods used by several different laboratories were obtained and examination disclosed that zinc oxide was generally used as the test pigment. In most cases it was used as a dry pigment although in some laboratories zinc oxide-linseed oil paste was used. The tests varied from simply mixing the zinc oxide and vehicle by stirring, to the actual preparation of a zinc oxide paint or enamel. In some cases carefully controlled conditions were maintained while in others this was not the case. Some laboratories aged the paints in a constant temperature cabinet, at a normal or somewhat elevated temperature, while others merely allowed the paints to age under the conditions of the laboratory.

Seven members of Group 1 cooperated in a study to develop a standardized test method. The objective of the group was to develop the simplest satisfactory method. For this investigation, two of the cooperators supplied seven liquids, representing different degrees of reactivity. They consisted of phenol formaldehyde varnishes and alkyl resin solutions. Portions of the liquids together with zinc oxide and a zinc oxide-linseed oil paste were supplied each investigator.

The results obtained by the various cooperators established:

1. That a satisfactory test method for determining the reactivity of paint liquids using zinc oxide could be developed.
2. That a zinc oxide-oil paste need not be used since satisfactory results are obtained with the dry pigment.
3. That it is not necessary to use a mechanical mixer for incorporating the zinc oxide into the liquid.
4. That storing the paint at an elevated temperature is not advantageous.
5. That although preliminary results can be drawn after 24-hr. storage, a longer period of aging, preferably five days, should be allowed before a definite decision is made.
6. To provide for those cases where the liquid's reactivity towards the zinc oxide is such that any bodying that will occur takes place during the incorporation of the two components, original consistency limitations are desirable.

Following a prescribed procedure but using available equipment, each laboratory tested the seven liquids and rated them as nonreactive, slightly reactive, moderately reactive, and reactive. As shown by the following summarization, the agreement between the various operators was excellent.

REACTIVITY TEST USING DRY ZINC OXIDE AND STORING PAINTS AT ROOM TEMPERATURE

Liquid No.	Operators						
	A	B	C	D	E	F	G
1	R	R	R	R	R	R	R
2	S	M	S	M	S	M	S
3	N	N	N	N	N	N	N
4	S	S	M*	M	M	S	S
5	M	R	R	M	R	R	R
6	S	S	S**	S	S	S	S
7	N	N	N	N	N	N	N

N—signifies nonreactive; S—slightly reactive; M—moderately reactive; and R—reactive.

* This operator rated this as R, but his measured increase in consistency was of the magnitude rated as M by the other operators.

** Again this operator, rated the liquid of higher reactivity, M, than his consistency figures indicate.

Instruments used for determining consistency:

Gardner Mobilometer—Investigators A, C, and E.
Modified Stormer Viscosimeter—Investigators A, B, D, F, and G.
Ford Cup—Investigator C.
Visual Inspection with Spatula—Investigators A, B, C, D, and G.

Based on the results of this work, a test method has been drafted and is now being considered by Committee D-1. Because of the interest in this method it is published here for information and comment.

PROPOSED METHOD OF TEST FOR REACTIVITY OF PAINT LIQUIDS¹

This is a **proposed method** and is published as information only. Comments are solicited and should be addressed to the Headquarters of the Society, 260 S. Broad St., Philadelphia, Pa.

1. *Scope*.—This method is intended for determining the reactivity between paint liquids and zinc oxide.
2. *Apparatus*.—The apparatus shall consist of the following:
 - (a) *Balance*.—Balance or scale sensitive to 1 g.
 - (b) *Containers*.—Friction-top cans.
 - (c) *Spatulas*.—Spatulas or suitable paddles.
 - (d) *Thermometer*.—Thermometer graduated from 0 to 100 C. and accurate to 0.5 C.
 - (e) *Paint Mixing Equipment (Optional)*.—Laboratory paint mixer or stirrer.
 - (f) *Consistency Measuring Apparatus (Optional)*.—Mobilometer, viscosimeter, plastometer or viscosity cup.
3. *Materials*.—The following materials will be required:
 - (a) *Paint Liquid*.—Varnishes, resin solutions, or other liquids used in the manufacture of paints, enamels, and lacquers are considered as paint liquids. If the viscosity of the liquid to be tested is such that dilution is necessary, the liquid reduced in a manner agreed to by the purchaser and the seller shall be used in the test.
 - (b) *Zinc Oxide*.—A standard Green Seal zinc oxide or other zinc oxide mutually agreed upon by the purchaser and the seller.

4. *Reactivity Determination*.—The zinc oxide and paint liquid in a ratio of 35 to 65 by weight shall be mixed to a uniform paint. Usually 210 g. of zinc oxide and 390 g. of liquid are ample. The zinc oxide and liquid shall be

¹ Under the standardization procedure of the Society, this proposed method is under the jurisdiction of the A.S.T.M. Committee D-1 on Paint, Varnish, Lacquer, and Related Products.

mixed by alternately adding portions of the pigment and liquid. The additions should be regulated so that a fairly stiff paste is produced. After all the pigment and sufficient liquid has been added to produce a paste, the paste shall be reduced to a paint by gradually working in the remainder of the liquid. The total mixing operation shall not take longer than 30 min. The mixing may be done in a suitable container by hand with a stiff spatula or a paddle or with a suitable mechanical mixer. The temperature of the paint shall then be brought to $25\text{ C.} \pm 0.5\text{ C.}$ and its consistency determined by a method mutually agreed upon by the purchaser and the seller. It may be determined by visual inspection with a spatula or using any of the usual instruments, such as the Gardner mobilometer or the Stormer viscosimeter. Limits for the consistency of the fresh paint should be agreed upon by the purchaser and the seller. The paint shall then be transferred to a friction-top can and stored under normal room conditions. The can shall be filled to within at least $\frac{1}{4}$ in. of the top and the lid tightly inserted. After 24-hr. storage and again after 5-day storage (Note) the paint shall be thoroughly mixed, brought to $25\text{ C.} \pm 0.5\text{ C.}$ and the consistency determined, using the same procedure as used in determining the consistency of the fresh paint.

NOTE.—Preliminary indications of the reactivity of the liquid are obtained after 24-hr. storage, but final decision should be made following the consistency determination after the 5-day storage. By mutual agreement between the purchaser and the seller, any specific period of storage may be used.

5. *Grading.*—The liquid shall be graded as nonreactive, slightly reactive, moderately reactive, or reactive. If the consistency of the aged paint is the same or less than that of the fresh paint, the liquid shall be graded as nonreactive. If on aging the consistency increased slightly but not sufficiently to be of practical significance, the liquid shall be graded as slightly reactive. If on aging the consistency definitely increased but the product would still be usable, the liquid shall be graded as moderately reactive. If the paint on aging bodied objectionably, livered or gelled, the liquid shall be graded as reactive. The purchaser and the seller shall agree on the maximum increase in consistency that will be allowed.

Some Suggested Practices in the Estimation of Particle Size Gradation of Granular Materials¹

by J. R. Gran²

THERE has been an increasing awareness of the effect of sub-sieve fineness on the properties of pulverized materials; for example, the covering power of mineral pigments and the rate of hardening of portland cement are now known to be dependent upon grain sizes much smaller than the meshes of the finest sieves. This

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Discussion intended for publication is of course subject to review by the Committee on Papers and Publications. Address all communications to Society Headquarters.

Determining the Depth of Color of Varnishes

Many schemes have been proposed for determining the color, or rather depth of color, of varnishes, but no simple, satisfactory one is yet available.

Aside from elaborate spectrophotometers and colorimeters, efforts to measure the color of varnishes have been made along the lines of simple comparisons with liquid or glass standards.

In selecting a standard, one soon discovers that varnishes are by no means alike in hue. Some are redder or yellower at the same time that they are darker or lighter in hue. Hence a compromise in the color of the standard must be made. It is for this reason that Subcommittee IX on Varnish, of Committee D-1, has described the problem as one of depth of color, or color intensity.

Liquid standards may be used in two ways.

1. Bottles containing liquids whose concentration of coloring matter ranges from low to high are prepared, and the sample is matched against them.

2. The liquid and sample may be matched in a Duboscq type of colorimeter in which the thickness of the layers of liquid and varnish may be varied. This method gives more accurate results, but is more expensive.

Glass standards may be used in somewhat the same way, corresponding to the first method, separate colored glass plates being used. In the second method a glass wedge is used. For a greater range of color, the varnish may be put in a hollow wedge.

Mention has been made of the compromise in selecting the hue of the comparison standards. It is much easier to make comparisons if varnish and standard are of the same hue, but the system is no longer low in cost if series of standards have to be made in several colors.

The presence of turbidity in some varnishes is also a disturbing factor in determining depth of color. Turbidity usually makes the color of the varnish appear lighter.

Circular No. 425, of the Scientific Section of the National Paint, Varnish and Lacquer Assn., contains descriptions of various schemes for measuring the color of varnishes and other liquids. Subsequent to the publication of that circular, many photoelectric devices have been designed. Most of them, however, seem to be excluded from wide routine use by reason of their high cost. Nevertheless, this type of method is extremely useful for checking secondary standards.

knowledge and the realization of the necessity for closer control of the grinding processes, both for economy of operation and for uniformity of the product, have resulted in an intensive investigation of methods of determining sub-sieve sizes.

The determination of particle gradation is elusive—in

¹ Publication approved by the Director of the National Bureau of Standards of the U. S. Department of Commerce.

² Assistant Materials Engineer, Cement Reference Laboratory, National Bureau of Standards, Washington, D. C.



fact, an exact determination is probably unattainable. Different approaches, advanced by many investigators, yield widely differing results, and these controversies have added to the confusion of manufacturers seeking suitable tools for testing their product.

In general, there are only two principal methods in use for determining the particle gradation of granules up to 100 μ . These employ (1) microscopical examination and (2) measurement based on Stokes' law, either by elutriation or sedimentation. Each of these methods is based upon different assumptions, and, in addition, different investigators using the same general method vary their technique and interpretation of results. For this reason it is not surprising that a marked lack of agreement is obtained. Each method has its champion who is convinced of its superiority to all others as yielding results which approach most nearly some hypothetical "true" values of the particle sizes.

METHODS FOR MEASURING PARTICLE DIAMETERS

Microscopical measurement appeals to many as the ultimate in accuracy and is referred to as a "direct" method because of its visual nature. However, there is always difficulty about the selection of the dimension to be used as the equivalent diameter of an irregularly shaped particle.³ Ordinarily all particles are considered to be spheres with a diameter arbitrarily selected—either that which appears to the observer as a reasonable diameter, or the dimension parallel to a fixed axis, or, in some cases, the maximum or minimum visible dimension. Other investigators use various "shape factors" which are corrections based on the assumption of geometrical similarity between particles. One such scheme is the use of the harmonic mean of three dimensions, which gives the diameter of a sphere having the same ratio of surface area to weight as a parallelepiped of the dimensions of the particle.

Another factor, which most investigators neglect entirely, is the variation in apparent dimension of a microscopic particle with variation in index of refraction of the mounting medium.⁴ This variation may, in extreme cases, amount to 20 per cent, or more. Since the proper medium to use has not been determined there is an element of uncertainty in all microscopical particle measurements.

Microscopical examination is too slow and laborious to be of any great value as a routine control method; however, it is often the only method applicable to some materials—such as those composed of fibrous, flakey, or needle-like particles. Also, if used with painstaking care, it furnishes a check upon other methods. Because of its fancied exactness, it has been advanced as the ultimate standard by which all particle-size determination should be judged; a more rational view would be that, in many specific instances, the results obtained with the microscope, affected as they are by the subjective factors cited, should not be accorded any greater credence as to accuracy than those of any other method which has proven its worth in actual use.

In the elutriation and sedimentation methods (except

where these processes are combined with microscopical examination of fractionated material), the diameter of a particle is defined on the basis of Stokes' law for sedimentation. That is, the "Stokes' diameter" of a particle is the diameter of a sphere having the same resistance as the particle to motion through a fluid. Applied to sedimentation only, this equivalent sphere may be defined as having the same density and falling velocity as the particle. There is no reason to believe that this hypothetical diameter corresponds to a diameter obtained from visually measured dimensions of an irregularly shaped particle. Since no single measurement will more than approximately describe an irregular particle's geometrical properties (such as, surface area, volume, specific surface) and as the degree of approximation is unknown, it would seem logical in the practical estimation of particle-size distribution to adopt such a definition of particle size as Stokes' diameter, which may be arbitrary but is not subject to variations due to the observer's judgment. The validity of this practice has been recognized by the Society's Committee C-1 on Cement for several years.

SPECIFIC SURFACE

Because the speed of chemical reaction of granular materials depends on the surface area of the particles, it is customary in many industries to designate the sub-sieve fineness in terms of specific surface. This is defined as the surface area of the material per unit weight, usually in square centimeters per gram. It is calculated on the assumption of spherical particles from the equation:

$$S = \frac{6}{\rho D}$$

where S = specific surface,
 ρ = density of material, and
 D = surface mean diameter.

The surface mean diameter for a group of particles is equal to $\frac{\sum nd^3}{\sum nd^2}$, where d is the diameter of a single particle and n is the number of particles of this diameter. For fractions of relatively narrow size limits (narrow as measured by the ratio of upper to lower limit) a satisfactory approximation is obtained by taking the arithmetic mean of the limiting diameters. This is the usual practice for fractions coarser than 10 μ . For material finer than 10 μ , which contributes the major portion of the surface area of all fine powders, the error introduced into the calculated specific surface by assuming the mean diameter on this basis may be large.

For example, assume that on a given portland cement it is found that 30 per cent by weight is finer than 10 μ . Theoretically, the surface mean diameter of this fraction may be anywhere from molecular size up to practically 10 μ . In different cements it is conceivable that this value may actually vary from about 2 to 8 μ , depending upon the grinding characteristics of the material and the type of equipment used. The contribution of this fraction to the surface of 1 g. of the whole cement would correspondingly vary from 2800 to 700 sq. cm.

Unless the method of determining the size distribution of these minute particles can remove this element of uncertainty, no calculation of specific surface can be justified

³ G. St. J. Perrott and S. P. Kinney, "The Meaning and Microscopic Measurement of Average Particle Size," *Journal, Am. Ceramic Soc.*, Vol. 6, pp. 417-439 (1923).

⁴ D. L. Bishop, "A Sedimentation Method for the Determination of Particle Size of Finely Divided Materials (Such as Hydrated Lime)," *National Bureau of Standards Journal of Research*, Vol. 12, p. 173 (1934).



on the basis of theoretical accuracy. For practical reasons, it is impossible to separate the 0 to 10 μ fraction into enough sub-fractions to fix precisely the surface mean diameter. The difficulties encountered in microscopical examination have been pointed out; sedimentation is not applicable because these extremely fine particles tend to agglomerate before observations of their falling velocities can be made; and elutriation requires such low air velocities that clean fractionation is doubtful.

From the standpoint of manufacturing control and acceptance testing—at least of many materials—the ideal of absolute theoretical accuracy in specific surface determination is somewhat academic. What is needed is a measure of fineness that can be correlated with the performance of the material in actual use. Traxler and Baum⁵ propose the use of the volume mean diameter for designating fineness because it “emphasizes the finer fractions to a smaller degree.” However, the concept of specific surface has been widely accepted by technicians in many fields because it is believed that the properties of a powder are closely related to its surface area. The present crude approximations of specific surface are considered indicative of the effect of grading upon the performance characteristics of materials and, therefore, should not be discarded until more precise methods are obtainable.

In this connection it may be appropriate to point out that many technicians making routine specific surface determinations do not recognize the limitations to the precision of the methods they are using. One often finds results of specific surface recorded to the nearest square centimeter per gram, when in actuality the nearest hundred square centimeters represents a degree of accuracy that is unobtainable. With this in mind, it will be seen that much of the lack of agreement between different methods is more apparent than real; and also that the stubborn insistence upon the importance of the differences in assumptions is rather absurd. It is suggested that, as a basis for agreement, the assumptions that enjoy the widest acceptance should be generally adopted. At present these seem to be those of A.S.T.M. Tentative Method of Test for Fineness of Portland Cement by Means of the Turbidimeter (C 115 - 34 T).⁶

COMPARISON OF TWO METHODS ON PORTLAND-PUZZOLAN CEMENTS

The testing of cement for Bonneville Dam affords an example of the differences encountered when two methods of particle-size measurement are used. The specifications call for a portland-puzzolan cement consisting of three parts by weight portland cement and one part calcined puzzolan material. It was thought that the low opacity of the puzzolan ingredient would make a turbidimetric method unsatisfactory, and a hydrometer was specified instead. However, because of the time that could be saved in testing such a large number of samples by the more rapid turbidimetric

method, a series of tests was made by L. A. Wagner with hydrometer and Wagner turbidimeter using the following materials:

Material	Color	Density
Portland cement	gray	3.22
Quenched blast-furnace slag	white	2.90
Puzzolan No. 1	old rose	2.66
Puzzolan No. 2	light pink	2.37

The procedure for making the hydrometer tests is given in the specifications for portland-puzzolan cement for Bonneville Dam and also in a paper presented at the Thirty-ninth Annual Meeting of the American Society for Testing Materials⁷; for the turbidimeter tests, the procedure is given in A.S.T.M. Method C 115 - 34 T.⁶

First the particle gradations of the above ingredients were determined, the weight and surface distribution curves being shown in Figs. 1 to 4. Next, three mixtures were prepared having the following compositions and their densities were calculated from those determined on the ingredients.

Mixture	Density
3 parts portland cement and 1 part quenched blast-furnace slag	3.13
3 parts portland cement and 1 part puzzolan No. 1	3.06
3 parts portland cement and 1 part puzzolan No. 2	2.95

Surface and weight distribution curves for each of the three mixtures were obtained for both methods of analysis in two ways: (1) the “calculated” curves were obtained by adding three quarters of the ordinates of the curves for cement to one quarter of the ordinates for the puzzolan materials; (2) the “observed” curves were obtained from tests of the actual mixtures. These curves are shown in Figs. 5 to 7.

It was pointed out that any evaluation of specific surface for a material uniform in chemical composition is arbitrary. In dealing with a mixture of two materials of different physical properties using a sedimentation method, serious complications arise which make the results for such materials even more questionable. The grading of the two ingredients is likely to vary considerably; therefore, the proportion of each in a given fraction can only be guessed at. Also, each fraction will have two sets of limiting diameters corresponding to the densities of the two ingredients. Since all calculations of specific surface are based upon the geometrical and physical relations of fractions of comparatively narrow limits, this uncertainty as to the composition of the individual fractions introduces an additional uncertainty into the analysis not encountered when a homogeneous material is used.

Using the usual assumptions, the following equation for the surface area of a fraction, the limits of which are set by the time of settling, applies for a two-component mixture:

$$S = \frac{6 w_1}{\rho_1 D_1} + \frac{6 w_2}{\rho_2 D_2}$$

where S = total surface area of the fraction,
 w_1, w_2 = weight of each component in the fraction,
 ρ_1, ρ_2 = density of each material, and
 D_1, D_2 = “Stokes’ diameter” of the particles of each material, the arithmetic mean of the limiting diameters being used.

⁵ R. N. Traxler and L. A. H. Baum, “Measurement of Particle Size Distribution by Optical Methods,” *Proceedings, Am. Soc. Testing Mats.*, Vol. 35, Part II, p. 457 (1935).

⁶ *Proceedings, Am. Soc. Testing Mats.*, Vol. 35, Part I, p. 777 (1935); also 1936 Book of Tentative Standards, p. 399.

⁷ S. B. Biddle, Jr., and Alexander Klein, “A Hydrometer Method for Determining the Fineness of Portland-Puzzolan Cements,” *Proceedings, Am. Soc. Testing Mats.*, Vol. 36, Part II, p. 310 (1936).



Distribution Curves

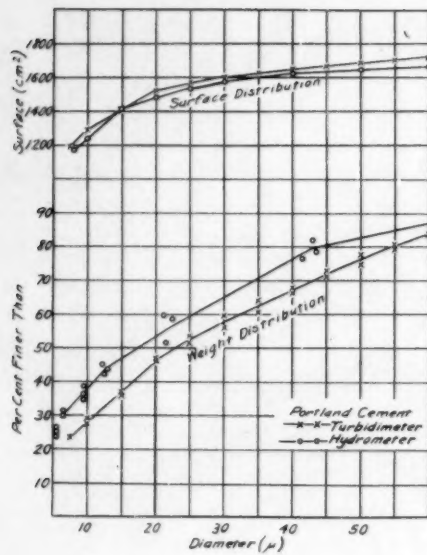


Fig. 1—Portland Cement.

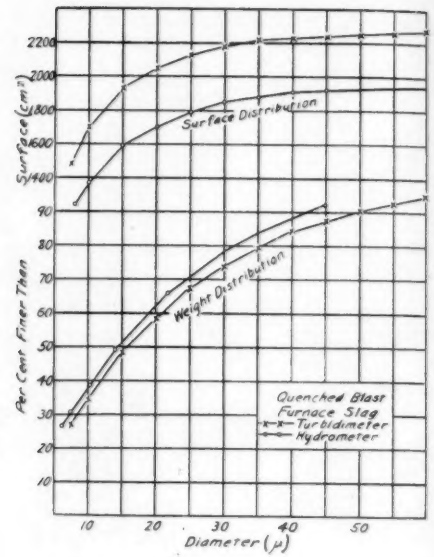


Fig. 2—Quenched Blast Furnace Slag.

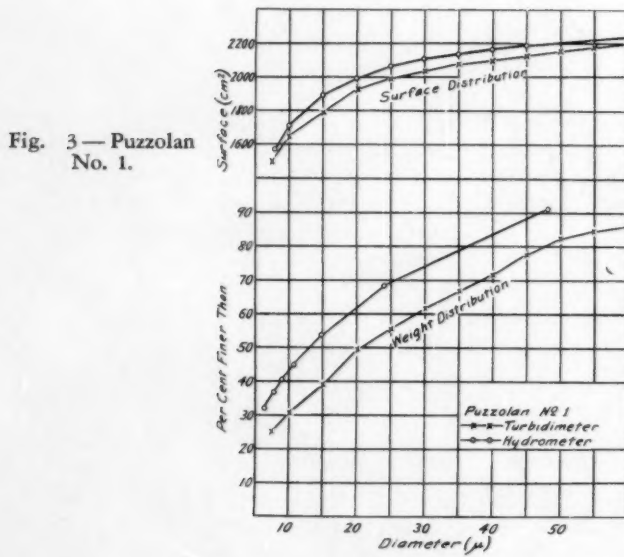


Fig. 3—Puzzolan No. 1.

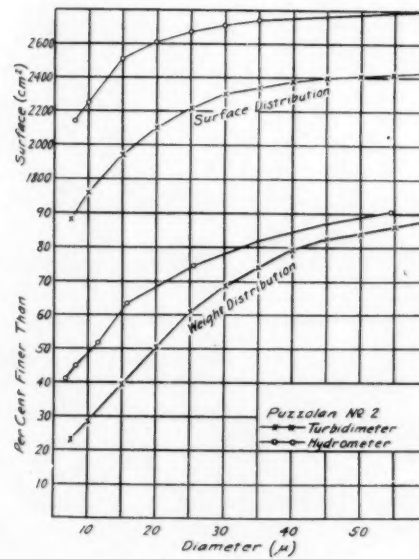


Fig. 4—Puzzolan No. 2.

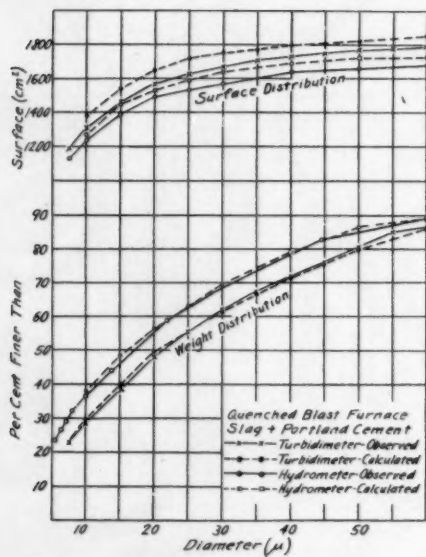


Fig. 5—Blend of Quenched Blast Furnace Slag and Portland Cement.

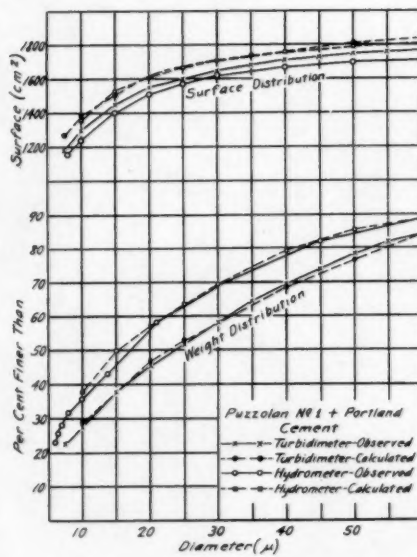


Fig. 6—Blend of Puzzolan No. 1 and Portland Cement.

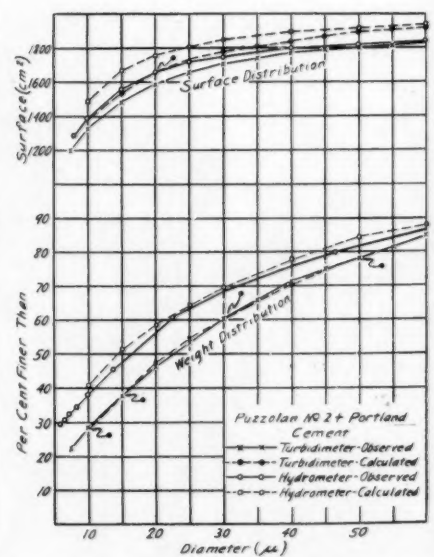


Fig. 7—Blend of Puzzolan No. 2 and Portland Cement.

With a turbidimeter, the surface, S , may be measured by the opacity of the suspension, but before this can be converted into known units, an integration of all the fractions must be made and the sum of the weights of the fractions equated to the known total weight of the sample. This summation is impossible unless the ratio w_1/w_2 for each fraction can be determined. From the composite density of the suspension as determined with the hydrometer, the weight of the fraction $w_1 + w_2$, can be calculated, but the surface S could be computed only if the above ratio is known. For this latter, no satisfactory method is known.

If the densities of the two ingredients of the mixture are the same, the above difficulty is not encountered. To even approach a definite particle-size determination by any sedimentation method, one must make the assumption that each ingredient has the density of the mixture. This is permissible if the densities of the two ingredients do not differ too widely. This was done in the tests on these puzzolanic cements—which explains the difference between the observed and calculated values.

An examination of the curves for each separate ingredient reveals that the hydrometer invariably indicates a finer size distribution by weight than does the turbidimeter. However, the calculated specific surfaces are not always higher because particles less than 2.7μ were neglected in the calculations for the hydrometer method.

In comparing the "observed" and "calculated" weight distribution curves for the mixtures and for any one method, it will be seen (Figs. 5 to 7 inclusive) that there is good agreement. However, the "observed" specific surface is invariably lower than the corresponding "calculated" value by about 4 per cent for the turbidimeter and about $4\frac{1}{2}$ per cent for the hydrometer. If the "calculated" values for either instrument are accepted as being the correct results, the degree of agreement between the "observed" and the "calculated" values becomes a measure of the suitability of the instrument for the analysis of such mixed materials. On this basis there is little choice between the two methods. However, there are three undesirable features of the proposed hydrometer method. First, it is time consuming, a single test taking $1\frac{1}{2}$ hr. for readings alone. This is objectionable not only from the standpoint of economy but also because it may allow agglomeration of the particles to take place. Second, the hydrometer bulb is introduced into and withdrawn from the suspension eight times during the test, which inevitably results in considerable agitation of the suspension and interferes with the free fall of the finer particles. This pumping action probably accounts for the fact that the hydrometer indicates a finer grading by weight than the turbidimeter. Third, the hydrometer does not measure the density of the suspension at any definite level and, therefore, cannot correctly measure particle size.

To illustrate the third feature, assume that a suspension is made of particles all of which are 10μ (40 g. cement in 800 g. kerosine), that the density of the kerosine is 0.810 and the density of the suspension is 0.840. As the particles

settle the hydrometer readings must vary from 0.840 at the start to 0.810 when all the cement is below the lower end of the bulb. Since the distance from the 0.810 mark to the end of the bulb is about 28 cm., this would take approximately 1 hr. and the sample would have an apparent range in size from about 8 to 40μ , or more. The only reason that the distribution curve for an actual cement approximates those obtained by other methods is that the hydrometer distorts every fraction.

The results of the tests shown here do not reveal any large discrepancies that could be ascribed to differences in the optical properties of the several ingredients used. The conclusion is that such errors in a turbidimetric determination are negligible, and the greater initial cost of the turbidimeter over the hydrometer will be more than compensated for by the time saved with the former instrument.

CONCLUSIONS

In selecting a method of making particle-size determinations, one should keep in mind that at present there is no method which will yield theoretically correct results. The values obtained are as arbitrary as the hardness numbers used in metals testing—and their usefulness is of much the same nature. That is, they must be interpreted in terms of the apparatus and method of calculation used. However, the approximate nature of the results does not detract from the value of the method if it aids in producing a suitable and uniform product in an economical manner.

Practical considerations should determine the choice of apparatus and method. General use of a particular method for the same or closely related materials is an advantage, because this fact indicates that the results of this method have been correlated with the properties dependent upon fineness. Speed and ease of making determinations should not be overlooked—not only for economy, but also because it leads to efficiency when used for control purposes.

For different materials, different interpretations of observations are probably necessary. For any one class of materials, it would be advantageous for all investigators to use the same interpretation of data. For example, in dealing with hydraulic cements, much confusion could be avoided if the computations of specific surface for all methods of securing data were standardized as follows:

1. Define particle size as Stokes' diameter.
2. Set the limits of all fractions at convenient, uniform sizes.⁸
3. Take the surface mean diameter of any fraction as the arithmetic mean of the limiting sizes.
4. Treat a blended cement as a homogeneous material.

Acknowledgments: Acknowledgment is made to L. A. Wagner, who obtained all test data on the portland-puzzolan cements, and P. H. Bates, who outlined the work and suggested several important changes and additions.

⁸ Since A.S.T.M. Tentative Method C 115-34 T has been so widely accepted, it is suggested that the following fractions be used: 0 to 7.5, 7.5 to 10, 10 to 15, 15 to 20, 20 to 25, 25 to 30, 30 to 35, 35 to 40, 40 to 45, 45 to 50, 50 to 55, and 55 to 60μ .



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No. 88

October, 1937

And Published

IN AN explanation of the purposes of the Society, it is often stated that one of its important major activities, "the promotion of knowledge of engineering materials," is "effected through investigations and research by committees and individual members of the Society and by joint researches with other groups, the results of which are presented as reports and papers at Society meetings—and published." It is obvious that no matter how many research projects an organization may have under way, if the data and information developed are effectively buried in the files of those carrying on the work, the efforts are entirely wasted. Only through widespread dissemination of the data developed can the intensive and long-time efforts that are frequently involved, in addition to the financial cost, be justified.

In the A.S.T.M., as in most societies which are concerned with research, there is a definite provision whereby data that are considered of utility to the members and those concerned with our field, can be printed and widely distributed. While the actual preparation and publication of the A.S.T.M. *Proceedings* may year after year come to be thought of as more or less of a mechanical proposition, the *Proceedings* are in one sense the crux of the Society's research work, for it is they which make available to representatives of industry the results of the major efforts in the field of materials research.

Obviously there is not room in all the pages of this, or in fact, in half a dozen, BULLETINS to review adequately the vast amount of valuable data which have appeared in the *Proceedings* since they first began appearing some 40 years ago, but a kaleidoscopic view of the volumes say for 1931-1935 inclusive may bring home the point we are emphasizing. In the five volumes of the *Proceedings*, there were printed a total of 226 technical papers and 217 committee reports. In the latter, of course, there is frequently a predominance of discussion on the standardization activities, but withal, the reports each year contain in the form of appended subgroup reports or papers sponsored by the committee data of great value that have been developed through committee efforts.

Schedule of Meetings

DATE	COMMITTEE	PLACE
November 4...	C-12 on Mortars for Unit Masonry	Washington, D. C.
November 4, 5...	B-4 on Electrical-Heating, Electric-Resistance and Electric-Furnace Alloys	Washington, D. C.
November 5...	C-1 on Cement	Washington, D. C.
November 12...	Research Committee on Effect of Temperature on the Properties of Metals	Columbus, Ohio
November 16...	C-4 on Clay Pipe	Chicago, Ill.
November 17...	C-15 on Manufactured Masonry Units	Washington, D. C.
November 18...	C-11 on Gypsum	Washington, D. C.
March 9, 1938...	REGIONAL MEETING	Rochester, N. Y.
June 27-July 1...	ANNUAL MEETING	Atlantic City

A technical paper on the other hand, while it may be concerned with standardization, largely is prepared by the author to publicize information and data he and his organization believe are significant. The Society *Proceedings*, offering as they do an opportunity for the technologists and engineers in industry to disseminate results of research, are basically of the greatest importance in carrying out the Society's co-major purpose of "promoting the knowledge of materials."

It would be remiss not to point out that both the papers and reports are widely referred to in connection with various problems. Hardly a day goes by when there is not a communication received at Society Headquarters asking whether A.S.T.M. has published any data on this or that subject. Very frequently from the hundreds of papers and reports in the *Proceedings* helpful references can be cited.

Comments on Proposed Standards

ONE of the basic principles underlying the development of A.S.T.M. standards is that *everyone* interested in a specification or test method shall have an opportunity to participate in its development—by expressing viewpoints in committees and before the Society, or presenting data relevant to the subject considered or in other ways.

During September and October, the tentative standards which were approved at the annual meeting or by Committee E-10 on Standards are edited and published. In order to stimulate comment and criticism these are brought to the attention of trade associations and other organizations interested, business journals, and, of course, their widespread use in the various phases of production and consumption tend to stimulate comment.

One purpose in issuing proposed standards in tentative form is to elicit constructive criticism and comment, of which the standing committees in charge take due cognizance before recommending adoption as a formal standard. In this connection each A.S.T.M. member can be of service by reviewing critically tentative standards in which he or his company is interested or by bringing them to the attention of other interested parties, to the end that finally a standard will be adopted which will represent a true consensus of industry, be practical, complete and authoritative. Comments should be forwarded to Society Headquarters.



Research Must Go Forward

RESEARCH is the backbone of standardization - without research there can be no intelligent standardization. The recognition of this accounts for the fact that the Society is so definitely interested in aiding and abetting research.

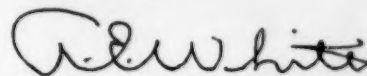
Of course, not all research work leads to standards, although most of it, in due time, does result in recommended practices, standard specifications and tests, definitions and the like. Many standards represent private manufacturing practice and cover details of manufacturing procedure essential for the production of similar material. In fact, in many instances, the manufacturer of a given product is in a much more intelligent position to prepare a specification than is the consumer. This condition very definitely existed a few years ago; although with consumers now taking a more active interest in the quality of the products they are purchasing, many of them, through their technical organizations, have as thorough a knowledge of the products required as the manufacturers themselves.

In the development of specifications, two fields of research are vital to the Society. One is in the field of increased knowledge of engineering materials and the other related to improvements in methods of testing. Too often specifications are written without true knowledge with regard to the limitations imposed. For instance, we have seen committees in session for an entire day discussing whether the sulfur content for a given steel specification should be 0.04 or 0.045 per cent. This, in itself, may appear to be a trifling matter. Producers feel they should have 0.045 per cent sulfur, believing that the consumers will get as good a product as they would with the lower limit. Also, they visualize that with an 0.045 per cent sulfur limit a number of heats which would otherwise be rejected would be accepted. The loss of heats is a matter which must be considered. It represents an economic loss which must be paid for either by the consumer or by the producer. In the long run, the consumer pays for it. In many cases where limitations are set it is essential to undertake comprehensive research programs to determine the proper rejection values. An instance of this is the work carried out by the committee studying the effects of sulfur and phosphorus on steel. What is true in this particular case of a specification for steel is true in many other instances, not only with reference to steel specifications, but in all other fields as well.

Furthermore, it is essential in the development of specifications that standardized methods of testing be used—otherwise there can be no correlation between the data obtained from different laboratories. In many lines of endeavor acceptable methods of testing have already been worked out, whereas in other fields there is still much to be done in this connection. This latter statement applies particularly to the newer fields in which the Society is becoming active.

All told the A.S.T.M. committees have under way some 50 active projects on materials properties and over 70 other investigations on methods of testing. This work must go forward, whether it be under the direction of committees

preparing specifications, special research committees working solely within the Society, or research committees working in collaboration with other organizations.



President

Items on 1937 Ballot Adopted

THE 1937 letter ballot on recommendations affecting A.S.T.M. standards was canvassed on September 1 and showed that all items listed on the ballot were adopted. In addition to recommendations involving the adoption as standard of some 21 tentative standards and the adoption and immediate incorporation of revisions in 25 existing standards, the ballot covered several amendments to the By-laws involving various changes itemized in the annual report of the Executive Committee.

The canvass showed that 599 legal ballots had been cast. On many of the items the votes were all affirmative and in other cases a scattering of negative votes was received. There was only one item on which as many as five negative votes were recorded, so that the requirement of a two-thirds approval of those voting was met in every case. While the full returns will not be published, any member who desires a record of the vote on any item can obtain this from Society Headquarters.

All of the revised standards, with the exception of two in which the revisions were of a very minor nature, and the newly adopted standards appear in the 1937 Supplement to the Book of A.S.T.M. Standards which has been distributed to each member of the Society and to the purchasers of either part of the Book of Standards. There were also transmitted with the Supplement stickers which can be placed in the 1936 Book of Standards indicating the revised or discontinued standards.

Dudley Medal Committee Appointed

THE Committee on Award of the Charles B. Dudley Medal has been appointed by the Executive Committee and consists of the following members:

E. F. Kelley, *Chairman*, Chief, Division of Tests, U. S. Bureau of Public Roads
Harold Farmer, Chief Chemist, The Philadelphia Electric Co.
C. E. MacQuigg, Dean, College of Engineering, and Director, Engineering Experiment Station, Ohio State University

This committee will review the eligible technical papers presented at the 1937 annual meeting in New York City and select the one of outstanding merit which constitutes an original contribution on research in engineering materials. The Medal will be awarded at the Forty-First Annual Meeting in Atlantic City, June 27-July 1, 1938. This Medal was established in 1925 by voluntary subscriptions from members of the Society as a means of stimulating research, recognizing meritorious contributions to the *Proceedings*, and in commemoration of the first President of the Society whose leadership has profoundly influenced A.S.T.M. development.



Several Publications Issued

A NUMBER of the publications which are scheduled to be issued in 1937 and which were listed on the special order blank sent to members in September, have been completed and satisfactory progress is being made on the remaining volumes. Included in the books issued are two compilations of standards—one covering petroleum products, 385 pages, and the other A.S.T.M. standards and related information on textile materials, a 306-page book. The latest edition of this pamphlet is considerably larger than previous ones and bespeaks the intense activity of Committee D-13 on Textile Materials.

The Symposium on Lubricants, which featured four technical papers with extensive discussion presented at the 1937 Regional Meeting, has been issued as a 90-page book. The Symposium on Wear of Metals which was held at a district meeting in Philadelphia in April has been completed. This comprises 105 pages and provides latest information on current thoughts on this important subject. The Symposium on Corrosion Testing Procedures, also held at the 1937 regional meeting, is at the point of completion. This will contain some 135 pages. The annual reports of Committees A-5 on Corrosion of Iron and Steel, 48 pages, and B-6 on Die-Cast Metals and Alloys, 54 pages, have been issued. The former includes an extensive report on the country-wide corrosion tests on wire and wire products, while the latter includes two important papers—one on "Brass Die Castings" and the other on "A Study of Die Design Changes for the Improvement of the Soundness and Uniformity of Test Bars."

Publication of the four viscosity-temperature charts covering Saybolt and Kinematic viscosities is nearing completion and numerous orders for pads of these charts will be filled in the very near future. Another publication which has been distributed to all members and to purchasers of the 1936 Book of Standards is the 1937 Supplement to the book which gives all the new standards adopted this year and also the standards in which revisions were adopted. The Marburg Lecture on "Plastics: Some Applications of the Different Classes, Methods of Testing" has been issued in the form of an 18-page reprint.

Finally, the 1937 Book of A.S.T.M. Tentative Standards which is the only publication giving all of the tentative specifications and tests (with the exception of those covering chemical analysis of metals, issued in a special publication) is being printed, with the expectation that copies will be available about the middle of November.

Supplement on Chemical Analyses of Metals

CHANGES have recently been made in two of the tentative methods given in the volume on Methods of Chemical Analyses of Metals—the revised methods covering Quantitative Spectrochemical Analysis of High Grade Pig Lead for Copper, Bismuth, Silver and Nickel (E 25) and of Zinc Alloy Die Castings for Minor Constituents and Impurities (E 27). The changes, recommended by Committee E-2 on Spectrographic Analysis, were approved by Committee E-10 on Standards in August. These revised methods have been published in a special pamphlet which supplements the volume containing all the methods. A copy is furnished to purchasers of the volume and members can obtain a copy without charge by writing to Society Headquarters.

UNIQUE INTEREST COLUMN

Editor's Note.—From time to time, our attention has been directed to unusual and very interesting items, special photographs, unique stories, old-time specifications, etc., and at the suggestion of certain members it has been decided to institute a "unique interest column" in the BULLETIN. Because of the unusualness of the items, it is believed they will be of wide general interest, even though they may refer to a specific field. Material for this column will be welcomed from any of the members and those who may have information in their files or know of sources where appropriate items can be obtained are urged to send them to Society Headquarters. It is planned that the items used will relate to the materials field, but they may not necessarily refer specifically to standardization or testing. The column will be essentially a members' column and the names of members submitting items will, of course, be given.

Rubber Trees and Tires

More than 50 million rubber trees are required to produce the some 80,000 long tons of crude rubber used annually by one of the large companies in the rubber industry according to a recent report. In the Far East the average tree is estimated to yield between three and four pounds of dry rubber yearly. It is estimated that about 170,000 natives are engaged yearly in tapping and collecting latex from the 50 million trees. The average weight of rubber in a pneumatic tire, adjusted in accordance with the proportionate number of various sizes produced for passenger cars, buses, trucks, farm implements, tractors and other vehicles, is about 16½ lb., so that the total annual output of four or five trees is necessary for each tire on present-day automotive equipment. (Submitted by Arthur W. Carpenter)

Reorganization of Committee C-12

SEVERAL years ago it was decided to disband Committee C-12 on Mortars for Unit Masonry because of a number of difficulties which arose resulting in the inability of the committee to make definite progress in its work. The interest of many members and organizations in the Society who were concerned with problems in the field of mortars has not diminished and the Executive Committee some time ago authorized the organization of the committee on a somewhat different basis than the one on which it was originally developed. Invitations have been extended to a number of those who are directly concerned with the proposed work of the committee and it is expected an organization meeting of the committee may be held in the near future. J. W. McBurney, Senior Technologist, National Bureau of Standards, has accepted the appointment as temporary chairman and preliminary plans for the new committee have been developed.

While the scope of the committee will not be formally accepted until the organization meeting, it is tentatively planned that the committee will concern itself with (a) the study, review, development and adoption of methods of test for masonry mortars and sand for masonry mortars. Methods of test for cementitious materials are not included in the scope of this committee; (b) the preparation of definitions of terms, nomenclature, etc., relating to masonry mortars; (c) preparation and adoption of specifications for mortars for use with units of burned clay or shale, sand lime, concrete and stone, and similar materials used in unit masonry, other than those intended for use as refractories.

Further announcements concerning the progress of this new committee will be made.



XV. Long-Time Society Committee Members

Fifteenth in the Series of Notes on Long-Time Members

THERE are presented below as a continuation of the series of articles in the ASTM BULLETIN comprising notes on the outstanding activities of long-time A.S.T.M. members, outlines of the work of three additional members. In general the men whose activities are described in this series have been affiliated with the Society for 25 years or more and have taken part in committee work for long periods of time. No definite sequence is being followed in these articles.

H. H. QUIMBY, Consulting Engineer, Philadelphia, Pa., began his industrial life in 1875 with Clark-Reeves & Co., bridge builders. Later he worked in the drafting room and became squad leader for the Phoenix Bridge Co. In 1892



O. C. Cromwell

H. H. Quimby

Herbert Abraham

he was appointed Chief Engineer of the Phoenix Iron Works, serving until 1900 when he began the manufacture of pressure gages. For ten years beginning in 1902 he was Engineer of Bridges, Bureau of Surveys, City of Philadelphia. He took an active part in the organization of the Department of City Transit in Philadelphia, and when this was formally organized became Chief Engineer, serving until 1923. Since that time he has been consulting engineer on various projects in Philadelphia and other centers, chiefly on bridge, highway and other construction work.

One of the early members of the Society, his affiliation dating from 1903, he has taken an active part in various committee projects. His membership on Committee A-1 began in 1914, and for many years in addition to his individual membership he represented Committee C-2, serving in this capacity with Richard L. Humphrey and Samuel Tobias Wagner. He had a long period of service as a member of Committee C-2, having become a member in 1913. He acted as one of the representatives of the Society on the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete and was A.S.T.M. representative on the Masonry and Reinforced Concrete Committee of the Structural Division, American Society of Civil Engineers. From 1930 to 1932 he was a member of the A.S.T.M. Executive Committee.

HERBERT ABRAHAM, President, The Ruberoid Co., New York City, manufacturers of asphalt and asbestos building products, was graduated from Columbia University in 1903 with the degree of B.S. in chemistry. He entered the employ of The Ruberoid Co. and was charged with the responsibility

of developing its first research and product control laboratory at South Bound Brook, N. J. He was Chief Chemist and Research Director until 1913, during which time he was concerned with the testing of asphalts and other bituminous substances. In connection with this work he devised a number of testing instruments. From 1913 to 1924, when he became President of the company, he was successively, Assistant Manager in Charge of Sales, General Sales Manager, and Vice-President.

Mr. Abraham has been a member of the Society since 1907. His committee activities have largely been devoted to membership on Committee D-8 on Bituminous Waterproofing and Roofing Materials, where he has served since 1915. He has been a member of numerous subcommittees for many years and was a representative of Committee D-8 on the Society's Committee on Nomenclature and Definitions.

The author of a book on "Asphalts and Allied Substances" in which there is an important section on testing methods, he has also contributed articles on bituminous substances to various trade and scientific publications. One of his early papers in the A.S.T.M. *Proceedings*, in 1909, dealt with "Improved Instruments for the Physical Testing of Bituminous Materials."

In 1917 and 1918 Mr. Abraham served as chairman of the Roofing Committee of the War Industries Board. He is President of the Asphalt Shingle and Roofing Industry, and a member of the American Chemical Society and the Society of Chemical Industry (London).

O. C. CROMWELL, Assistant to Chief of Motive Power and Equipment, Baltimore & Ohio Railroad Co., Baltimore, Md., after leaving high school studied in the Maryland Institute in Baltimore. He became draftsman in the Baltimore & Ohio Railroad Shop at Mt. Clare, and then entered the machine shops of the company. Later he became draftsman in the Bureau of Steam Engineering, Navy Yard, Washington, D. C., and then reentered the employ of the railroad where he was concerned with the construction of locomotives and rolling stock as well as their design. He was successively Assistant Draftsman, Chief Draftsman, and Mechanical Engineer.

A member of the Society since 1906, he has been particularly active in the work of Committee A-1 on Steel, on which he has served since 1914. He has taken part in the work of the subcommittees on structural steel, steel forgings and rolled steel wheels and tires.

Mr. Cromwell is one of the charter members of the Baltimore Engineers' Club, and is a past-chairman of the Baltimore Section of the American Society of Mechanical Engineers and is at present on the General Committee of the Railroad Division Section. He is active in the work of the American Association of Railroads, is a member of the Wheel Committee and serves on the Committee on Locomotive and Car Construction. He is a member of the Board of Managers of the Maryland Institute of Mechanical Arts.



PROPOSED METHOD OF TEST FOR FILE SCRATCH HARDNESS OF METALLIC MATERIALS¹

This is a **proposed method** and is published as information only. Comments are solicited and should be addressed to the Headquarters of the Society, 260 S. Broad St., Philadelphia, Pa.

It is well known that steel may attain a very high degree of hardness on the surface due either to work hardening or to self-hardening. This skin hardness may be only a few thousands of an inch in depth. When the usual hardness testing equipment of different types is used on such a surface, the thin skin is penetrated and the readings obtained are not at all indicative of the surface hardness. In other cases it is desirable to obtain the surface hardness on metals when it is not feasible to use regular hardness testing equipment. A rather simple method for such hardness determinations is a file scratch test.

1. *Scope*.—This method covers a procedure for determining the scratch hardness of metallic materials in which specially prepared files are used.

2. *Preparation of Files*.—(a) For this file scratch hardness test, it has been found most satisfactory to use 8-in. square files with tapering sides. These plain-carbon-steel files ordinarily have a Rockwell hardness of approximately C 65. By drawing such files at suitable temperatures, the hardness numbers can be reduced to any desired degree. The following draw temperatures have been used to obtain the corresponding Rockwell C hardness values on a series of files:

Draw Temperature, deg. Fahr.	Rockwell Hardness, C Scale (Brale Penetrator, 150-kg. load)
No draw	C 65
400	C 60
550	C 55
660	C 50
760	C 46
840	C 41
960	C 35
1040	C 30
1080	C 25

NOTE.—It should be noted that the files may be calibrated in terms of other hardness values, such as Brinell hardness numbers.

(b) The files in such a series, drawn to different hardness values, shall be ground at the file-end to a needle-point. This needle-point must be maintained by regrinding when necessary.

3. *Procedure*.—It is quite necessary to have a fairly smooth, clean surface on the specimen to be tested. The hardness shall be measured by determining the softest file which will scratch the surface of the specimen. To conserve the points of the files, it is desirable to start the scratch test with the use of the hard files. The precision of the test will naturally depend upon the number of files in the series. An experienced operator can conduct this scratch test through feel: a file that does not scratch, slides over the surface; whereas, a file which scratches, grips the surface.

¹ Under the standardization procedure of the Society, this proposed method is under the jurisdiction of the A.S.T.M. Committee E-1 on Methods of Testing.

Meeting of the Highway Research Board

THE Seventeenth Annual Meeting of the Highway Research Board of the National Research Council will be held in Washington, D. C., Tuesday, November 30 to Friday, December 3, 1937. The meeting will extend over four days to provide opportunity for discussion of important road and transportation problems. Much of the time will be devoted to open departmental meetings on Economics, Design, Materials and Construction, Soils Investigations and Roadside Development.

All day Tuesday, November 30, will be the open meeting of the Department of Soils Investigations. At the opening Board session on Wednesday morning papers and reports relating to soils and maintenance will be presented. Topics include: bridge foundations, cofferdams, embankments, stabilized roads, cement stabilization, sand-asphalt stabilization.

On Wednesday afternoon there will be open departmental meetings on Materials and Construction and Roadside Development. Thursday's meetings will include a general session in the morning on Finance, Roadside Development, and Materials and Construction. Topics in the latter group cover durability tests of cement, fillers and cushion courses, heat of hydration of cement, vibration of concrete, freezing and thawing tests of aggregates, properties of asphalts, and others. The afternoon session is on Highway Safety. Friday will be devoted to Design and Economics, a common general session in the morning and separate departmental meetings in the afternoon.

Book on Corrosion Resistance of Metals

THE volume on "Corrosion Resistance of Metals and Alloys" by R. J. McKay and Robert Worthington, published by The Reinhold Publishing Corp., New York City, is the American Chemical Society Monograph No. 71, and is one of the best volumes dealing with corrosion of metals that has been issued. Engineers concerned with materials of construction and with corrosion should find it of particular value. The authors have made a long study of corrosion and have been in the fortunate position for many years of having had first-hand experience with a vast number of corrosion problems in industry.

The first hundred pages have been devoted to general and theoretical phases of the subject. Here the authors discuss factors dealing with the rate of corrosion, such as movement, electrolytic effect, solid films, and temperature. They also cover forms of corrosion, corrosives, and corrosion properties of metals.

The other part of the volume deals with the corrosion behavior of specific metals and alloy groups. A chapter is devoted to each group. The general corrosion resistance of the base metal and its alloys is discussed, followed by the effect of a dozen or more of the most commonly encountered chemicals and gases, and high temperatures. Many references are given throughout for the benefit of the engineer who wants to secure additional information on any particular point under discussion. And to each chapter is appended a bibliography. Copies of this 492-page publication, 6 by 9 in., can be obtained at \$7 each from the publishers.



Two Active Members Die

Two active members who had taken a leading part in important phases of the work of the Society have recently died—R. A. Bull, Consultant on Steel Castings, Chicago, and C. L. Hippensteel, Member Technical Staff, Bell Telephone Laboratories, New York City.

ROBERT ALEXANDER BULL 1874-1937

Major Bull died on July 28, 1937, in Anniston, Ala., where he had gone on one of his regular consulting trips. He passed away in his sleep from a heart attack. One of the outstanding leaders in the foundry industry, particularly the steel castings field, he had taken a very prominent part in many of its important phases.

After receiving his education at Butler College, B.A., and St. Louis University, M.A., he served as chief inspector for various companies. He was associated with a number of steel foundries and the Robert W. Hunt Co. He was General Superintendent, Commonwealth Steel Co., later Vice-President and General Manager of the Chicago Steel Foundry Co., and he also held these same positions with the Duquesne Steel Foundry Co. Major Bull was Director, Electric Steel Founders' Research Group from 1920 to 1934. He was commissioned Major in Ordnance Dept., A.E.F., in March, 1917, serving until February, 1919, mostly in France.

A member of A.S.T.M. since 1908, he had been active in the work of Committee A-1 on Steel since 1921, held membership on Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, was a member of the Chicago District Committee, and for several years had been a member of the Research Committee on Effect of Temperature on the Properties of Metals. One of his most recent activities in the latter group was as chairman of the finance committee in raising a considerable sum to carry on sponsored researches in this field. One of his very valuable contributions to A.S.T.M. work was in connection with the development of specifications for steel castings. He was called upon on two occasions to head up special committees to undertake difficult standardization activities.

Very active in the work of the American Foundrymen's Assn., he was a Past-President, 1915-1916, and he received the A.F.A. Joseph S. Seaman Medal in 1927 for his "contributions to the association and to the foundry industry."

In his untimely death, many members of the Society lose an intimate friend and the Society a most active member over a period of many years who carried out ably numerous important tasks in its behalf.

CLAUDE LORRAINE HIPPENSTEEL 1897-1937

Claude L. Hippensteel, Member of Technical Staff, Bell Telephone Laboratories, Inc., died after an illness of several months in Montclair, N. J., on Monday, September 20. He passed away after a courageous and up-hill fight to regain his health. He was a very active member of the Society and took a leading part in important A.S.T.M. work.

Mr. Hippensteel received his education at Purdue University, graduating in 1921 with the degree of B.S. in Ch.E. He had been connected with the Bell Telephone Laboratories, Inc., in New York City since that time.

In the Society he had been particularly active in the work of the committees in the field of corrosion of ferrous and non-ferrous metals. He was a member of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, Committee A-5 on Corrosion of Iron and Steel and Committee B-6 on Die-Cast Metals and Alloys but perhaps his outstanding contribution to the work of the Society was as chairman of the Subcommittee on Galvanic and Electrolytic Corrosion of Committee B-3 on Non-Ferrous Metals and Alloys. This committee has extensive country-wide tests under way which have already produced valuable data. He was a representative of the Society on the Joint Committee on Exposure Tests of Plating on Non-Ferrous Metals and was active in the development of specifications for electro-plating issued jointly by the A.S.T.M. and the American Electro-Platers' Society.

Mr. Hippensteel was the author of numerous papers and reports. One of his important services to the Society was as a member for two terms (1930 to 1936) of Committee E-6 on Papers and Publications. He took a leading part in the development of the Symposium on Outdoor Weathering of Metals and Metallic Coatings and his last important work for the Society was in the organization of the Symposium on Corrosion Testing Procedures featuring the 1937 regional meeting.

An extremely likable person with a pleasing personality his death has brought a keen feeling of loss to his large group of friends and associates in the Society and especially to those who were closely associated with him in his industrial work and in his committee affiliations. His untiring devotion to the activities in which he participated have influenced greatly their progress and the Society in his death feels the loss of a very able and enthusiastic member.

Calendar of Society Meetings

(Arranged in Chronological Order)

- AMERICAN INSTITUTE OF CHEMICAL ENGINEERS—November 17-19, St. Louis, Mo.
- NATIONAL RESEARCH COUNCIL (HIGHWAY RESEARCH BOARD)—17th Annual Meeting, November 30 - December 3, Washington, D. C.
- AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS—Annual Meeting, December 3 and 4, Bellevue-Stratford Hotel, Philadelphia, Pa.
- AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Annual Meeting, December 6-10, New York City; Spring Meeting, March 23-25, Los Angeles, Calif.; Semi-Annual Meeting, June 20-24, St. Louis, Mo.
- AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—December 27 - January 1, Indianapolis, Ind.
- SOCIETY OF AUTOMOTIVE ENGINEERS—Annual Meeting, January 10-14, 1938, Detroit, Mich.
- AMERICAN SOCIETY OF CIVIL ENGINEERS—Annual Meeting, January 19-21, 1938, New York City.
- AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Winter Convention, January 24-28, New York City; Summer Convention, June 20-24, Washington, D. C.
- AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—January 24-28, Grand Central Palace, New York City.
- AMERICAN SOCIETY OF REFRIGERATING ENGINEERS—January 26-28, New York City.
- AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS—Annual Meeting, February 13-17, New York City.
- AMERICAN CONCRETE INSTITUTE—February 22-24, Chicago, Ill.
- TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY—Annual Meeting, February, New York City.
- AMERICAN RAILWAY ENGINEERING ASSOCIATION—March 15-17, Chicago, Ill.
- AMERICAN CERAMIC SOCIETY—Fortieth Annual Meeting, March 27-April 2, New Orleans, La.
- AMERICAN CHEMICAL SOCIETY—Semi-Annual Meeting, April 18-21, Dallas, Texas.
- AMERICAN WATER WORKS ASSOCIATION—Annual Convention, April 24-28, New Orleans, La.
- AMERICAN FOUNDRYMEN'S ASSOCIATION—May 14-19, Cleveland, Ohio.

Screen Wire Cloth Committee Withdrawn

COMMITTEE D-14 on Screen Wire Cloth, which was organized in 1920, and which completed a few years ago in cooperation with the National Bureau of Standards an extensive atmospheric corrosion test program on various types of non-ferrous insect screen cloth, recently requested that it be discharged since it had completed the work that lay before it. Accordingly, the Executive Committee approved the discharge of the committee and expressed its appreciation of the valuable services which it had rendered to the Society.

The Standard Specifications for Non-Ferrous Screen Cloth (Insect) (B 50 - 29) which were written by the committee have become obsolete and the committee's recommendation that the standard be withdrawn was approved.



NEW MEMBERS TO OCTOBER 9, 1937

The following 64 members were elected from July 19 to October 9, 1937:

Company Members (12)

AMERICAN AGGREGATE CO., W. H. Cloud, President, 1210 Waltower Building, Kansas City, Mo.
AMERICAN PHARMACEUTICAL ASSN., E. F. Kelly, Secretary, 2215 Constitution Ave., Washington, D. C.
CHAMPION SPARK PLUG CO., E. S. Twining, Chief Engineer, Toledo, Ohio.
DIAMOND ALKALI CO., H. G. Elledge, Research Chemist, Painesville, Ohio.
EDWARD VALVE AND MANUFACTURING CO., INC., THE, L. H. Carr, Metallurgist, 1200 W. 145th St., East Chicago, Ind.
FEDERAL PRODUCTS CORP., I. A. Hunt, Sales Manager, 1144 Eddy St., Providence, R. I.
HARSHAW CHEMICAL CO., THE, F. H. Emery, 1945 E. Ninety-seventh St., Cleveland, Ohio.
HINDE & DAUCH PAPER CO., THE, Pierre Drewsen, Chemical Engineer, Sandusky, Ohio.
INTERNATIONAL ASSOCIATION OF MILK DEALERS, R. E. Little, Executive Secretary, 309 W. Jackson Boulevard, Chicago, Ill.
TALCO ASPHALT AND REFINING CO., Box 1011, Mt. Pleasant, Tex.
WESTERN ASPHALT ASSN., B. H. Maynard, Secretary, Quinby Building, 650 S. Grand Ave., Los Angeles, Calif.
YOUNG SPRING AND WIRE CORP., L. A., G. P. Nelson, Metallurgist, 9200 Russell St., Detroit, Mich.

Individual and Other Members (47)

ARGENTINA MINISTERIO DE MARINA, Estado Mayor General, División Informaciones, Santa Fé 2128, Buenos Aires, Argentina.
BARCLAY, J. THOMAS, Chief Inspector, Vandergrift Works, Carnegie-Illinois Steel Corp., Vandergrift, Pa.
BENOLIEL, L. OSMOND, Technical Dept., Quaker Chemical Products Corp., Conshohocken, Pa.
BIRD, P. G., Research Director, National Aluminate Corp., 6216 W. Sixty-sixth Place, Chicago, Ill.
BOEDECKER, R. W., Technical Service Division, Colgate-Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J.
BOGIN, CHARLES, Chief Lacquer Chemist, Commercial Solvents Corp., Terre Haute, Ind.
BRANDT, C. D., Research Engineer, Whitin Machine Works, Box 126, Whitinsville, Mass.
CLARK, E. R., Chemical Engineer, United States Hoffman Machinery Corp., 219 Lamson St., Syracuse, N. Y.
CLARK, M. M., Manager, Bar and Semi-Finished Materials Division, Metallurgical Dept., Carnegie-Illinois Steel Corp., 208 S. LaSalle St., Chicago, Ill.
COX, F. F., Chemist, McGraw Paint and Asphalt Co., 5604 W. Sixty-third St., Chicago, Ill.
D'ADRIAN, A. L. DUVAL, President, Mississippi Valley Research Laboratory, 901 S. Eighteenth St., St. Louis, Mo.
DAVIS, J. J., Superintendent, Finishing and Inspection Depts., Carnegie-Illinois Steel Corp., Ohio Works, Youngstown, Ohio.
DEBING, L. M., Chief Chemist, Resinox Corp., Edgewater, N. J.
DODD, G. A., Southern Kraft Corp., 228 N. LaSalle St., Chicago, Ill.
FRANKLIN, F. H., Research Chemist, Fleming Manufacturing Co., East Providence, R. I. For mail: 17 Dorchester Ave., Providence, R. I.
GIBSON, A. J., Special Officer, Lac Inquiry, London Shellac Research Bureau, India House, Aldwych, London, W. C. 2, England.
GROWER, R. M., Testing Engineer, New England Inspection Bureau, Inc., 38 Memorial Drive, Cambridge, Mass.
HATELY, F. HALL, Development and Research Engineer, American Felt Co., 315 Fourth Ave., New York City.
HERITAGE, C. C., Development Engineer, Wood Conversion Co., Box 456, Cloquet, Minn.
HERZIG, A. J., Chief Metallurgist, Climax Molybdenum Co. of Michigan, 14410 Woodrow Wilson Ave., Detroit, Mich.
HOCH, HORACE, Research Engineer, The McKay Co., Lock Drawer 747, York, Pa.
HOLMES, J. A., Director of Service, National Aluminate Corp., 6216 W. Sixty-sixth Place, Chicago, Ill.
HURST, T. F., Chief Chemist, Thomas F. Hurst Laboratory, 413 Tenth Ave., South, St. Petersburg, Fla.
JACKSON, E. W., General Service Manager, Caterpillar Tractor Co., 600 W. Washington St., East Peoria, Ill.
JONES, L. B., Engineer of Tests, Test Dept., The Pennsylvania Railroad Co., Altoona, Pa.
JUVE, W. H., Consulting Rubber Technologist, 124 Clemmer Ave., Akron, Ohio.
KANTER, J. J., Research Metallurgist, Crane Co., 836 S. Michigan Ave., Chicago, Ill.
KIELY, HELEN U., Technical Director, American Writing Paper Corp., 9 Main St., Holyoke, Mass.

KAPELSOHN, LEON, Director, Bureau of Standards, Hearn Department Stores, Inc., New York City. For mail: 1737 E. Fifteenth St., Brooklyn, N. Y.
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Catalogs and Folders Received

E. H. SARGENT & CO., 155 E. Superior St., Chicago, Ill. Scientific Laboratory Apparatus Catalog No. 50. Describes the large number of items dealing with industrial control, research and development, analytical, physical, organic and biological, chemical items and bacteriological, pathological and serological, medical equipment and supplies. In addition to a detailed subject index there is a short index to equipment for methods of the American Society for Testing Materials. 1245 pages.

E. H. SARGENT & CO., 155 E. Superior St., Chicago, Ill. Chemical Reagents Catalog No. 55. This covers organic chemicals, culture media, biological stains, standard solutions, minerals and ores, micro chemicals, etc. 275 pages.

PRECISION SCIENTIFIC CO., 1736 N. Springfield Ave., Chicago, Ill. Apparatus for testing cement, concrete and steels. Bulletin 220. Includes descriptions of many pieces of apparatus referred to in A.S.T.M. specifications and tests. Some 26 pages.

BAUSCH & LOMB OPTICAL CO., 636 St. Paul St., Rochester, N. Y. Catalog D-15 covering binocular microscopes of the Greenough type. Covers several different types of wide field instruments. 12 pages.

ADOLPH I. BUEHLER, 228 N. La Salle St., Chicago, Ill. Booklet describing various types of optical instruments and metallurgical apparatus which can be supplied involving metallographic cutting machines, mounting presses, grinders, polishers and holders. Also various types of microscopes. 12 pages.

LEEDS & NORTHRUP CO., 4930 Stenton Ave., Philadelphia, Pa. Pamphlets and folders describing insulation resistance test set; Micromax and other pyrometers; modified Schering bridge for measurements of dielectrics; apparatus for power factor measurements; Vapocarb-Hump and Homo furnaces for hardening, tempering and nitriding.

